October/November
1971
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In this Issue:

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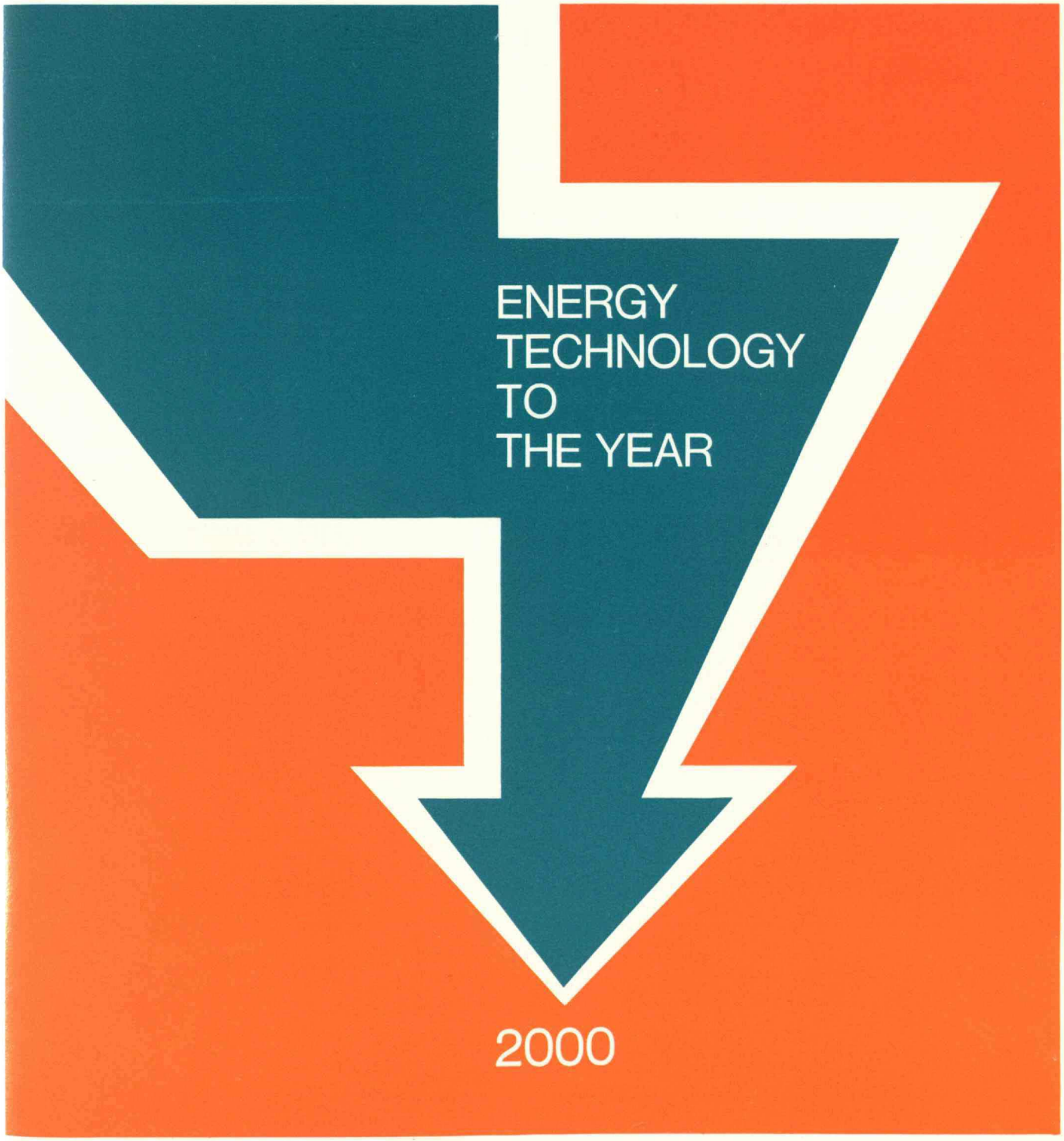
Hurricane Detection and Control

The Space Shuttle

Man's Impact on Climate

Technology Review

Edited at the Massachusetts Institute of Technology



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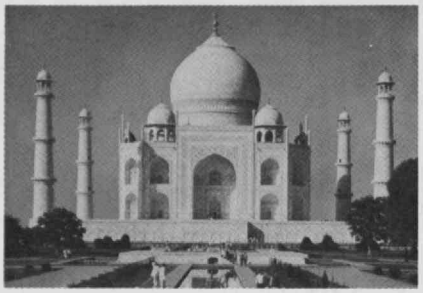

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Technology Review

Edited at the
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The First Line

On Youth and Innovation

At last June's baccalaureate, in one of his final official appearances as President of Harvard University, Nathan M. Pusey shared with Harvard parents and alumni some of his frustrations with today's young people: "While we talk about the quality of life and earnestly cry out for it, nevertheless animosity grows, social amenities in our common life decline, and the behavior of people toward each other steadily worsens. . . . We talk about love while behaving in a thoroughly unlovely manner. Some express rhapsodic concern for the environment, and spread pollution wherever they go. Some march and chant, smash windows, steal and misrepresent . . . and yet talk about beauty in life and profess concern for justice and loveliness and peace!"

All of us know Mr. Pusey's disappointments. But his view is wrong. Indeed, on the contrary, one may positively argue that the dramatic changes in values and goals which engulfed America in the 1960's could not have happened without the wisdom of the generation that is still under 30. Franklin D. Roosevelt may have given this country a social conscience, but only now have we begun to understand the full meaning of quality for all Americans' lives. A decade ago Ralph Nader would have been simply a member of the lunatic fringe.

Readers who doubt this judgment should perhaps have shared with this Editor the experience of a University of Toronto symposium on urban transportation this summer. Several hundred students from a score of American and Canadian engineering colleges came to Toronto to report their progress on entries for next summer's Urban Vehicle Design Competition (*see p. 71*), and there were long bull

sessions of "car talk"—about safety, bumpers, pollution, suspensions, fuel, and horsepower. Every student there understood the need for far more rational urban transport than we now have, and every student there already had some experience trying to design or build a prototype of his ideal.

When General Motors engineers arrived to exhibit three G.M. solutions for the urban vehicle problem—tiny two-seater cars (one electric, one gasoline-electric hybrid, one internal combustion) built in 1969—the students might have washed their hands of the whole greasy problem and gone home. For it was obvious that G.M.'s resources for designing automobiles and building prototypes are vastly superior to those of any engineering school; standardized parts and friendly machine shops abound in the G.M. empire.

But the U.V.D.C. will go on; the cars designed and built by today's college generation may well be more innovative than their elders'; and the U.V.D.C. cars will surely not be distinguished one from the other by the painted trim lines and removable canopy which led the G.M. public relations department to describe the electric car as having "fresh, attractive design," a "unique convertible appearance."—J.M.

The Editors' Desks

Energy Technology

Energy is every magazine's urgent interest this fall: a special issue of *Scientific American,* special attention in two issues of *Science and Public Affairs (The Bulletin of the Atomic Scientists),* and now *Technology Review*. . . . The reason for this universal emphasis on a single problem is obvious; we have suddenly discovered that energy is bought with more than a few cents per kilowatt, and that—in contrast to most economic laws—as our consumption increases the real price also increases. Indeed, here may be the issue over which will occur the ultimate confrontation between technology, natural resources, and environmental degradation.

Technology Review's contribution to the dialogue will take the form of a book-length symposium on energy technology to the year 2000, provided by special sections bound into this and the next two issues. The series will include—in addition to this month's articles on the energy system and on two contributors to our energy supply—papers on how best to deal with the inevitable by-products of energy production, how to use energy more efficiently, and how to make practical plans to meet realistic future needs. We acknowledge our debt to Robert J. Hansen, Professor of Civil Engineering, who chaired a 1971 M.I.T. alumni seminar at which many of our authors were speakers, and who has since been a source of counsel and encouragement.

The magazine business—even when viewed from ivied walls of academe—is a competitive one; our motto is: if you join them, beat them. These monthly supplements to the *Review* will later be collected, bound as a paperback, and offered to *Review* readers and others at modest cost.

An Older (?) New Look

With this issue, *Technology Review* inaugurates a modest change in what was once a highly controversial format. The pressures of economics are the same in Cambridge as everywhere else, and the generous margins and oversize format which have distinguished the *Review* for four years are a casualty of paper prices and postage rates. This first issue of the *Review*'s 74th volume also reveals other typographic changes, most of them tending, we think, to make our typography a bit more conventional. Changes of this kind usually stimulate readers to write letters—which we will welcome.

Assistant Editor

Technology Review announces with pleasure the appointment of O. Reid Ashe, who graduated from M.I.T. in electrical engineering in June, 1971, to be Assistant Editor. Mr. Ashe was for one year Managing Editor of *The Tech,* M.I.T.'s undegraduate newspaper, has reported for *Newsweek,* and will concentrate especially on helping *Review* readers keep abreast of the generation to which this month's editorial is dedicated.

Index to Volume 73

The index to Volume 73 of the *Review,* which concluded with the July/August, 1971, issue, continues in production; copies will be available late in the fall without charge—on request.

Authors

Manson Benedict
"Electric Power from Nuclear Fission," pp. 32-41
was the first Head of M.I.T.'s Department of Nuclear Engineering, founded in 1958; he relinquished this administrative assignment on July 1, 1971, to devote full time to teaching and research. A graduate of M.I.T. (S.M.'32, Ph.D.'35), he has had a leading role as consultant as well as educator in U.S. nuclear power developments throughout the past three decades. His article in this issue of the *Review* is adapted from a paper prepared for the spring, 1971, meeting of the National Academy of Sciences.

Richard G. Bowen and Edward A. Groh
"Geothermal—Earth's Primordial Energy," pp. 42-48
are associated with the Oregon State Department of Geology and Mineral Industries, Mr. Bowen as Economic Geologist and Mr. Groh as consultant. A native Oregonian, Mr. Bowen studied at the University of Oregon and before 1960 was a petroleum exploration geologist with the Standard Oil Co. (Ohio). Mr. Groh, a consulting geologist, has specialized in Oregon's recent volcanic terrain and geothermal potential.

John M. Logsdon
"Shall We Build the Space Shuttle?", pp. 49-57
is currently Assistant Professor of Public Affairs and Political Science at the George Washington University, Washington, D.C., where he is also associated with the Program of Policy Studies in Science and Technology; he is currently teaching in the University's graduate program in science, technology, and public policy and preparing a study of the decision-making process for future space programs. Dr. Logsdon studied physics (B.S.) at Xavier University and political science (Ph.D.) at New York University; he is the author of *The Decision to Go to the Moon: Project Apollo and the National Interest* (M.I.T. Press, 1970).

James W. Meyer
"Toward Hurricane Surveillance and Control," pp. 58-66
coordinated a preliminary study of the requirements for a hurricane reconnaissance aircraft radar system late in 1969 for the U.S. Air Force as a member of Division 4 (Radar) of Lincoln Laboratory; he returned to the topic to lead a more general study of air-borne severe storm surveillance in the summer of 1970 under sponsorship of the Advanced Research Projects Agency, upon which the present article is based. Dr. Meyer is now at the M.I.T. Center for Space Research to direct development of an electrical conductivity experiment to be deployed on the lunar surface by Apollo 17 astronauts.

David C. White
"Energy, the Economy, and the Environment," pp. 18-31
holds the distinguished Ford Professorship of Engineering at M.I.T. He first joined the Institute's Department of Electrical Engineering in 1952, following study (B.S.'46, Ph.D.'49) at Stanford University and teaching experience at the University of Florida. He has published extensively on topics in power generation and energy conversion, and he is now beginning a major new research program to analyze in detail the issues in U.S. energy supply and demand which he raises in this issue of *Technology Review.*

In addition to the distinguished authors of major articles in this issue (*see above*), the Editors call your attention with pride to the *Review*'s departmental contributors and to this month's book reviewers.

Among the former: **Robert C. Cowen**

("Science Review," pp. 6-7) studied meteorology at M.I.T. and almost ever since then has been Science Editor of the *Christian Science Monitor;* he is now stationed in Washington, D.C. **Victor Cohn** *("Washington Report," pp. 8-9)* is Science Editor of the prestigious *Washington Post,* now on a brief leave of absence to complete a book on the work of Sister Kenney against poliomyelitis. **Victor K. McElheny** *(National Report, pp. 9-10),* formerly stationed in Europe for *Science* magazine, is Science Editor of the *Boston Globe.* **Rex Malik** *("European Report," pp. 10-11)* is a British writer specializing in computers and communications, a frequent contributor to *New Scientist.* **Lucy Sloan** *("Special Report," pp. 11-12)* writes regularly on subjects in oceanography for a number of journals, including her reports published in *Technology Review.*

Two of this month's book reviewers deserve special notice. We're honored to publish Governor **Francis W. Sargent**'s review of *Man's Impact on the Global Environment* (pp. 84-85); Mr. Sargent studied at M.I.T. with the Class of 1939, was instrumental in conservation efforts which culminated in the creation of the Cape Cod National Seashore, and built a political career upon his record as Massachusetts Commissioner of Natural Resources. We also call readers' special attention to the review of Jay W. Forrester's *World Dynamics* by **George A. W. Boehm,** formerly a member of the Board of Editors of *Scientific American* who is now one of the *Review*'s friendly critics as a member of our Editorial Advisory Board.

Next Month

For December, more on Energy Technology to the Year 2000: three noteworthy original papers on the environmental issues raised by fuel combustion and power generation: "Must Fossil Fuels Pollute?" by Harry Perry and Harold Berkson of the Congressional Reference Service, Library of Congress; "Capturing Sulfur During Combustion," by Arthur M. Squires of C.U.N.Y.; and "Heat—the Ultimate Waste," by Donald R. F. Harleman of M.I.T.

Just as this issue reaches most readers, M.I.T. will be celebrating the inauguration of a new team: Jerome B. Wiesner as President and Paul E. Gray as Chancellor. The events will occasion a week-long campus introspection on the future of technology and of institutions devoted to its progress. Since they haven't happened yet the Editors cannot be more specific than to assure readers that these events and their subjects will be the focus of special attention in the next issue.

Letters

Population vs. Democracy?

Emilio Q. Daddario's comments in "Technology and the Democratic Process" (July/August, 1971) are noteworthy and on a topic far too often ignored. The dilemmas that he enumerates are indeed very real. I think, however, that the primary conflict, which Mr. Daddario touched upon, is more basic.

The increasing dependence on technology is only one manifestation of the rapid growth of population and the standard of living on our society. I believe the most severe threat to democracy results, ultimately, from population growth. As we grow larger and more urban, we must, by necessity, reduce our conflicts of interest and relinquish personal freedoms. Democracy and its freedoms may not be able to cope with the basic survival problems of a large, urban society of the future.

Raymond J. Giglio
Augusta, Maine

Wastes in the Deep Ocean

Someone should point out that one "obvious" statement in Robert Dean's article in the March issue (*"Ultimate Disposal of Industrial Waste: An Overview," pp. 20-25*) seems to be incorrect. He writes on page 23 that "general organic wastes that settle to the bottom (of the sea) will be decomposed by marine bacteria." But Jannasch *et al.,* writing in a recent issue of *Science* (171—19 Feb. 1971—p. 672), indicate that, apparently because of inhibition by pressure, microbial activity is reduced to such an extent that such normally short-lived items as bologna sandwiches have remained apparently perfectly edible after 10 months' exposure to deep sea conditions; apparently, after all, the deep sea is one of the worst possible places to dispose of organic wastes, if it is desired to recycle them biologically.

W. Richard Ristow
Providence, R.I.

The author is a member of the Division of Applied Mathematics at Brown University.—Ed.

Robert B. Dean replies:

Mr. Ristow has called our attention to a new observation of Jannasch *et al.* that was published after my paper went to press. The low rate of bacterial activity in the very deep ocean is surprising, but it is hard to see how it can cause serious problems with the disposal of organic wastes. We do not necessarily desire to recycle organic wastes in the ocean when we make use of the deeper parts

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A. Total number of copies printed *(net press run)*	48,466	50,700
B. Paid circulation		
1. Mail subscriptions	43,807	48,111
2. Sales through dealers and carriers, street vendors, and counter sales	30	33
C. Total paid circulation	43,837	48,144
D. Free distribution by mail, carrier or other means:		
1. Samples, complimentary, and other Free copies	1,272	1,389
2. Copies distributed to news agents, and not sold	0	0
E. Total distribution	45,109	49,533
F. Office use, leftover, unaccounted, and spoiled after printing	3,357	1,167
G. Total	48,466	50,700

I certify that the statements made by me above are correct and complete.

John I. Mattill, Editor

for disposal. The slow rate of bacterial decomposition is probably matched by a slow rate of transport from deep waters.

Mathematics of the Ancients

I suggest to Robert C. Cowen *("Bronze Age Europeans," June, pp. 2-3)* that it is theoretically possible that Alexander Thom will find at a distance of one diameter from the center of his inner Megalithic site, the centers of six circles which were laid out to surround the inner circle. I say this for the following reason:

A circle of D = 1 can be surrounded by only six circles of the same diameter. These six circles will each have a common point with the inner circle edge, but will have some space between each other. Then:

Where D = 1, then C = 3.1416 or pi

Where D = 2, then C = 6.2832

The combined D of the six exterior circles equals 6. This leaves a distance in pi of 6.2832 — 6. = .2832. A degree in terms of pi is 3.1416/360 = .00873. Then the slippage of .2832 divided by .00873 equals 32.44 where D = 2; and 32.44 divided by 6 gives a pi distance between each exterior circle of 5.406 where D = 2. Where D = 1 this amount would be halved, which is 2.703. This would mean that whatever unit the "ancestors" used as a unit would be multiplied by 2.703. This figure seems to be closely related to Dr. Thom's finding for a megalithic yard of 2.720 feet ± 0.003.

The 5.406° figure above may have some relationship to the rough 5° "wobble" of the moon in the orbit around the earth.

Howard C. Smiley
Memphis, Tenn.

Professor Thom's tribulations are perhaps more the rule than the exception when an "outsider" tries to contribute to a foreign field of expertise. I am sure we can all think of other examples—including Dr. William Shockley's struggle for funds in order to prove or disprove his theory that Negroes are less intelligent, as a race, than whites. Dr. Shockley is, of course, an electrical engineer; but he may very well have a valid sociological point. In any case, it behooves this nation to settle the matter, for it is crucial to the solution of our racial problems. Our present approaches are presumably predicated on the assumption that Negroes on the average are of equal intelligence as whites. If this is not true, then these approaches are doomed to failure; and we have done the Negroes and the whites a great disservice. It is tantamount, for instance, to trying to solve ballistics problems while denying the existence of gravity. There is no way it can succeed.

What really bothers me is that we hear of and laud the achievements of the Alexander Thoms; but what about those who, for one reason or another, did not prevail? The John Does—the William Shockleys?

Douglas L. Johnson
Edina, Minn.

Pollution: People vs. Steers

People like William E. Small *("Agriculture: the Seeds of a Problem," April, 1971, pp. 48-53)* like to take pot shots at the farmer because he does not have one united voice that speaks for all of agriculture. As far as pollution is concerned, we are all guilty of it. To wage an effective way against pollution will take the cooperation of industry, municipalities, and agriculture.

Agriculture's pollution problems center around soil and water movement. If you stop soil erosion and control water runoff, you stop nearly all agricultural pollution. Since the late 1930's farmers have been conserving the soil through the establishment of grassed waterways, contour farming, strip farming, etc. These practices have protected millions of tons of topsoil, kept water from flooding, and provided for the planting of billions of trees to improve the total ecology.

Why do we continue to overwork the animal-to-human waste ratio as Mr. Small did? He states that a cow generates as much manure as 16.4 humans. This is true, but few go on to point out that most animal waste, especially in Minnesota where feedlots are not concentrated, goes back to the fields, where it is incorporated and reused or recycled. It is not flushed down city drains along with dish water, bath water, laundry water, and garbage as is human waste. A human averages 75 gallons of waste per day, a steer 3.5 gallons in feedlot runoff. Rather than one steer equalling 15 people, the ratio is more like one person causing as much problem-creating pollution as 22 steers.

Roger Wilkowske
Waseca County Extension Agent
Waseca, Minn.

Green of Oregon

I read "The First Line" for May, 1971 *(p. 2)*, with disbelief, horror, shock, and plunging blood pressure. " . . . Rhode Island's distinguished Congresswoman Edith Green . . ." If you had ever driven on Oregon's roads, you would have remembered her great slogan: Keep Oregon's Green.

Howard Boroughs
Associate Dean of Graduate
Studies and Research
California State Polytechnic College
San Luis Obispo, Calif.

Science Review

Robert C. Cowen

Climate: The Headline and the Doubt

The trouble with climate is you have to distort the truth to get at the reality.

Computer modeling gives rough trends at best. Theories of climatic change are shaky. Our data base wobbles. Yet these uncertain tools give far better insight than guesswork into man's possible harmful impact on world climate. Too bad that it is the sometimes nightmarish aspects of their admittedly inadequate projections that tend to get the publicity.

The M.I.T.-sponsored Study of Man's Impact on Climate (SMIC) brought welcome perspective to this subject last summer. It followed up the 1970 SCEP (Study of Critical Environmental Problems). This time, in Stockholm, the Royal Swedish Academy of Sciences and the Royal Swedish Academy of Engineering Sciences were hosts for the meeting (June 28-July 16).

Once again as in SCEP (*see* Technology Review *for October/November, 1970, pp. 58-59 and for May, 1971, pp. 18-27*) a diverse group of experts—30 scientists from 14 countries—pointed up the need to understand the mechanisms and trends of climate and of man's likely influences on them. Scientists know enough already to suspect that the dustiness raised by man's activities might alter earth's radiation balance. They foresee possible deleterious effects of the high-flying supersonic transport (S.S.T.). They question influences of waste heat from the continued rise in energy consumption. They can't make specific predictions of disaster. But they know enough to feel the need to understand climate is urgent. Unfortunately, in public thinking this subtlety gets lost in the alarm raised by some of the climatic scenarios of the prophets.

You could see this in the recent environmental hoo-ha accompanying the debate on the American S.S.T. Limited theoretical studies suggest that water vapor and other materials injected into the stratosphere by S.S.T. engines might alter earth's radiation balance in possibly harmful ways. Or they might upset the ozone region which shields us from most of the sun's dangerous ultraviolet radiation (u.v.).

Ultraviolet Doom?

One of the most frightening projections came at the end of the debate last May. Chemist Harold Johnston of the University of California at Berkeley worked out the possible effects of oxides of nitrogen on the ozone layer. He used a Federal Aviation Administration estimate of 500 S.S.T.'s, each cruising the stratosphere seven hours a day, by 1985. He found that the nitrogen oxides might thin out the ozone shield by 50 per cent in two years or less. This could let in enough u.v. to blind animals, including humans, and probably kill many plants. Professor Johnston says the purpose of his report is to point up the importance of nitrogen oxides in considering S.S.T. pollution, a factor he feels SCEP and S.S.T. planners have unjustifiably discounted. He doesn't claim to know exactly what the effect on the ozone shield would be. But his alarming case study made the news.

SMIC took a look at the question again in July. It noted that the ozone shield depends on a balance between several chemical reactions, some of which are uncertain, and on poorly understood atmospheric transport mechanisms. Under

the circumstances, it concluded: "We do not believe that present data and knowledge permit drawing any firm conclusions as to the effects of supersonic transport combustion products on ozone concentrations in the stratosphere. We consider that answers to these questions should be produced before large-scale aircraft operation in the stratosphere becomes commonplace, and we believe that solutions might be produced by concentrated research."

Dusty Death?

Consider, next, the icy threat of man's dustiness. S. I. Rasool and S. H. Schneider of the Goddard Space Flight Center ran computer-model studies of possible effects from plausible continued increases in the dustiness from farming, burning fossil fuels, and so forth. They report: "An increase by a factor of four in the equilibrium dust concentration in the global atmosphere, which cannot be ruled out as a possibility within the next decade, could decrease the mean surface temperature by as much as 3.5° K. If sustained over a period of several years, such a temperature decrease could be sufficient to trigger an ice age!"

Drs. Rasool and Schneider meant to raise a warning about climatic ignorance, not about an ice age. After all, no one knows for sure that a 3.5°K. rise would trigger an ice age at all, let alone that dustiness will quadruple by 2000 A.D. They merely tried to show that man's activities could plausibly have serious climatic impact, so we had better find out what we are doing. But it was the ice age that got headlines.

SMIC, reviewing the dust question, notes that dustiness might indeed have serious effects. But physicists know so little about the optical and chemical properties of the particles, they can't make full use of computer modeling. They have so few data on radiative properties of polluted air, they can't verify the computer projections. In fact, scientists don't even know how much dust the atmosphere holds today. SMIC found a wide divergence in estimates, which its members were unable to resolve.

In short, the scientists know the dust could be a problem. And they know they need a great deal more knowledge in a hurry if they are to give meaningful assessments of possible danger here.

And so it is with other tantalizing climatic questions. World energy production is rising 5 to 6 per cent a year. That projects to something like a fivefold increase by the year 2000 in an energy flux that eventually degrades to waste heat. Industrial areas of 1000 to 100,000 sq. km. may evolve where man's heating will equal the net radiation from the sun. In many urban areas such heating has already had substantial local climatic effect. On a continental scale, SMIC concludes that man's presently insignificant contribution may rise to 1 per cent of the continental net radiation average in about 40 years. That still sounds small. But is it trivial climatically?

Then there's ever-changing land use. Great man-made deserts like the Sahara or Africa's grass lands show how much regional climatic impact man has already had. These impressive land features are attributed to grazing and farming practices. In fact, farming has already drastically changed 20 per cent of continental land areas, with attendant changes in water-vapor and heat budgets. What will the effect of urban sprawl and other modern changes be? American roads now cover 1 per cent of United States land. That's small compared to agriculture's 20 per cent. But, SMIC asks, is it insignificant for climate?

The great carbon dioxide scare is yet another example where frightening scenarios have obscured legitimate concern over our ignorance of what really is happening. Because CO_2 from fossil-fuel burning is accumulating in the atmosphere, because this might gradually change earth's heat balance through a "greenhouse effect," and because average global temperature did rise about 0.6°K. from 1880 to 1940, some Jeremiahs of the 1960's were predicting climatic disaster. But since 1940 the temperature average has fallen by over 0.3°K.—perhaps due to dustiness, although no one knows the reason.

The more meteorologists have looked at the CO_2 problem, the less inclined they are to predict any specific climatic effect right now. They just don't know enough to go out on that kind of limb. SMIC notes that CO_2 does appear to be accumulating at an average rate of about 0.2 per cent a year. Year by year fluctuations in that rate suggest that the processes that determine CO_2 retention in the atmosphere are also varying, in poorly known ways. SCEP had urged specific measurements to study this. SMIC finds the situation still so cloudy that it is "less ready" than SCEP even to recommend measurements. Detailed preliminary study of the whole problem of how CO_2 is shared between the ocean and the atmosphere is needed just to outline a program of observation to find out what is going on.

Climatology suffers from many decades of benign neglect. Our knowledge of what climate has done in the past is too sketchy, our theories of how climate operates are simply too crude, to cope with urgent demands to forecast how man may be influencing things. As SMIC explains, "with our present state of knowledge, we do not know how to relate cause and effect in such a complex system and, second, man-made effects will be obscured by the natural changes that we know must be occurring."

The Need to Know

Under the circumstances, it's relatively easy to spin out alarming forecasts of ozone destruction in order to oppose the S.S.T. politically. It's a simple matter to rivet public attention on such potential horrors as a new ice age. The real threat to fear, if one must have something to fear, is the fact that man does seem to have the potential to influence climate, and that we are in the dark as to what he may be doing. The remedy is determined, well-ordered research, not panicky efforts to halt various lines of modern development—although some projects, such as the S.S.T., could wisely be delayed until the environmental uncertainties are cleared up.

As SMIC points out, in spite of the underdeveloped state of climatology, "We now know enough of the theory of climate and the construction of climatic [computerized] models to recognize the possibility of man-made climatic change and to have some confidence in our ability ultimately to compute its magnitude."

Here indeed is a cause the environmental lobbies could push with profit. One wonders, though, if the environmental opponents of the S.S.T. will return to Congress and demand support for a thoroughgoing program of climatic research. It's just not as much fun as scaring the hell out of people.

"We know enough now to recognize the possibility of man-made climatic change. . . . Recent results, for example, concern the delicate balance of the processes which maintain the arctic sea ice. . . . A small change in air temperature or in solar radiation could bring . . . a climatic change of great significance to human life."

Washington Report

Victor Cohn

Lip-Serving Research While Cutting Muscle

It is hard to know what to say about the future of technology in a country that has been running its first trade deficit in 74 years, in large part because of growing invasions of foreign high technology—like Toyotas . . .

. . . A country that is wasting the talents of at least 50,000 unemployed engineers and scientists . . .

. . . A country that has been cutting its federal research and technology spending in real dollars for five years.

Is it time to say that we are on the way to becoming technologically second-rate, doomed to lag behind a future Japan and West Germany in productivity and living standards?

It may be a little early for this gloomy verdict—but not very much. Some federal decisions of coming months will play a large part in deciding our future role.

The present fact—so it seems to this reporter—is that the nation is failing to put science and technology to vital work while understandably rejecting them as gods and wreckers.

This nation has simultaneously cut defense and aerospace spending, spurned the S.S.T., and—in the same mood of anti-science—in fact cut the total effective amount of all scientific and medical research, despite recent hoopla over an "extra $100 million" to fight cancer. At the same time, it has not even considered truly major technological attacks on urban blight, bollixed transportation, increasing population, or the despoiled environment.

"We have to fight guerilla war" to get even minor contracts to assault environmental problems, one M.I.T. scientist complained this summer. Just a few years ago large chunks of federal money were being pushed at him—to help make missiles and explore space.

Curbing—and Promoting—Growth

We are, in short, heeding the Lewis Mumford who rejects the megamachine while ignoring the Mumford who advises self-control and self-direction and closer accord with the self-renewal of nature.

By this test, the United States obviously cannot afford to become endlessly "richer" at the expense of the less fortunate and the environment. But neither can it afford to become so poor, just by heedlessness, that it cannot solve its great problems. The greatest problem of the next decades, it is becoming increasingly clear, will be to curb growth for growth's sake while encouraging growth to nourish and protect us.

Can we do both? Can we do either? The high-minded words spoken, they must be applied to our immediate political and economic problems.

The High-Technology Imbalance

In this sense, even the most zealous environmentalist or anti-technologist might listen when a Secretary of Commerce Maurice Stans reports that the U.S. trade deficit with Japan in high technology alone—cars, electronics, roller and ball bearings, office machines—could reach $2.5 billion this year, compared with a $100 million 1965 surplus. We have long run a deficit with Japan in low technologies—shoes, textiles, iron and steel. The new thing is that, worldwide, our long-standing low-technology deficit is continuing to climb, while our high-technology exports *have stopped growing.*

These facts made a genuinely frightened Mr. Stans tell the House Science Subcommittee on July 27 that U.S. trade, wages, and living standards all will drop unless U.S. industrial research is strengthened. (Mr. Stans also thinks the government should be easier on industrial pollution. We'll take that up another time.) Two days later the same cause summoned—of all people—Assistant Secretary of the Treasury for Economic Policy Murray L. Weidenbaum, just about to return to a Washington University post.

Weidenbaum had preached only last October against squandering taxpayers' money for major scientific and technological programs "on faith, without hard data on expected benefits." That speech had widely been taken as a signal of administration opposition to "science for science's sake"—an official whammy to the proposition that products like transistors and computers often spring unexpectedly out of basic ground.

Now, argued Weidenbaum on July 29—at last taking those hard trade and technological unemployment figures seriously—the U.S. may have become "too niggardly in support of science, engineering, and the related intellectual activities that are so fundamental to our growth and progress." . . . "Economists who have seriously studied the subject" tend to conclude that we may now be underinvesting in civilian research and development "from the viewpoint of economic growth and productivity." . . . We need to increase support for both basic research and selected development, with enough money "to properly support competent scientists and related professionals"—those brainy 50,000—and allow "reasonable" growth in their numbers.

Stans reported that "we are studying" four possible actions:

☐ Financial help like grants, cost sharing, loans, or tax breaks for industries that cannot go it alone on costly developments like—so he said—"50 different projects, major opportunities in technology," in which the U.S. could take the lead with more federal aid. Among these he listed vertical take-off planes, ocean mining and deep-ocean platforms, air-cushion land and water vehicles, high-speed ground transport, burnable plastics, oil from shale and tar sands, and fast-breeder nuclear reactors.

☐ Changing the anti-trust laws that prevent joint research ventures. Both Federal Reserve Board Chairman Arthur Burns and Treasury Secretary John Connelly—potent fellows—had also been floating anti-antitrust trial balloons.

☐ Establishing a single federal focus, perhaps a new agency or division (which Stans would like in his Department) to identify and back new technologies.

☐ Encouraging international industrial standards, which could include getting U.S. industry on the rest of the world's metric standards. A federal study panel has recommended a 10-year changeover to the metric system. The idea has not stirred much comment in Congress, but, tied to the newly obvious need to make U.S. industry world-competitive, it just might pick up speed.

More Lip-Service Support?

The Stans and Weidenbaum statements came only a few weeks ahead of the President's New Economic Policy. The hard technological reality is that even Mr. Nixon's dollar adjustment and trade bars may not make much difference if Japan's productivity keeps growing. Both Japan and West Germany are devoting a greater percentage of their gross national product to developing civilian technologies *(see "America's Technological Dilemma," by J. Herbert Holloman and Alan E. Harger in the July/August issue of* Technology Review).

Last April White House science adviser Dr. Edward E. David, Jr., stood before reporters at San Clemente and announced an ambitious-sounding Administration search for "new technological initiatives . . . with the objective of keeping the country in the forefront and great."

As of this writing there has been announced only a breeder-reactor program that the nuclear industry thinks too stingy and environmentalists think ill-considered. Doughty Dr. David is now busy fighting for a fiscal 1973 budget and very possibly a tax program that can accomplish further goals. He has allies now in several branches of the executive. But he faces the President's desire to keep total spending down and a good deal of opposition to any further incentives for industry.

An added billion or two now for research and development might make all the difference to the technological future. Instead:

☐ Dr. David last January happily announced a fiscal 1972 research and development budget proposal of $16.7 billion, up 7.6 per cent, the first substantial-sounding increase in some time. With defense cuts and few large boosts elsewhere, the Congressional authorization may turn out to be only some $16 billion, up maybe 3 per cent.

☐ The largest Administration response to technological unemployment has been a start on a $42-million Labor Department relocation program—a mere token. A new National Science Foundation study predicts that by 1980, unless things drastically change, there will be a surplus of 41,700 Ph.D.-engineers and Ph.D.-scientists alone, not to mention those with lesser degrees. The main Administration hope for technological reemploy-

ment is in restarting the economy. Several Congressional Democrats argue for major retraining and reconversion programs.

☐ Universities, suffering academic depression yet eager to switch from defense to civilian research, are finding the support in areas like urban problems, education, and environment maddeningly thin.

☐ Support of physics research and employment of physicists both bode ill for future scientific strength—if physics, as many scientists believe, is indeed a source of basic strength for applied areas. By last February only two out of three 1970 physics graduates had found jobs where they could use their training extensively.

All this seems to say that Mr. Nixon's Administration, like Mr. Johnson's, has lip-served scientific and technological progress, while continuing to cut the country's technological muscle. Will this change? In his September economic policy address, the President at last promised that "in the next session of Congress I shall present . . . new programs to insure the maximum enlistment of America's technology."

Even if strong programs are presented and voted, their effects could hardly be felt before 1973. Meanwhile the U.S. technology lag may continue to grow. Erecting trade or dollar bars may keep out a few Sony TV sets or Toyotas for the moment; but only new knowledge, applied, will produce new, still unimagined U.S. industries to outsell and outdate these "yesterday" products.

National Report

Victor K. McElheny

In Praise of "Big Science"

Why the very costly American program to put a series of increasingly accurate ultraviolet observatories in orbit around the earth? After nearly three years in space, a $95 million Orbiting Astronomical Observatory has produced enough information on important astrophysical problems to give an unequivocal answer to the argument.

It now seems safe to say that this remarkable hardware has:

☐ Proven the existence of a variety of types of spottily-distributed cosmic dust (including grains of graphite) absorbing light from stars.

☐ Proven that much of the material in comets is plain water ice.

☐ Shown that ultraviolet light from an exploding supernova mounts in intensity almost in direct proportion to the declining intensity of visual light (at least until the infrared intensity begins building).

☐ Probed the chemical composition of the upper atmosphere of Earth and the atmospheres of Mars and Jupiter.

☐ Come upon evidence that the invisible companion of the star Beta Lyrae may be one of those postulated "black holes" where matter is collapsing so intensely that no signal escapes.

☐ Catalogued thousands of ultraviolet light sources over about 10 per cent of the sky (finding all of them to have visual light counterparts)—the Celescope experiment of the Smithsonian Astrophysical Observatory.

☐ Recorded the spectra of hundreds of individual stars (showing young stars to be unexpectedly hot and older stars to be unexpectedly cool in the ultraviolet)—the University of Wisconsin experiment.

The success of OAO-2, signalized in a two-day conference on its results at the University of Massachusetts in Amherst in August, is whetting scientific appetites for the fourth and last OAO of the current series, scheduled for launch next year. Its payload will include ultraviolet detectors from Lyman Spitzer's group at Princeton University and x-ray equipment from the Universities of London and Leicester. The pointing accuracy is to be 0.1 second of arc (compared to the design figure of 1 minute of arc on OAO-2).

OAO-2, the most complicated of automated spacecraft to be launched to date, has been something of a cliff-hanger. OAO-1 failed because of electrical arcing in its star-trackers. The next OAO launched never even went into orbit because of a failure of the launch vehicle. OAO-2 itself has weathered episodes where it began to tumble out of control. Three of its six star-tracking devices have failed. There have been failures in the mechanisms for steering the craft and a gradual degradation to uselessness of the four "uvicon" tubes of the Smithsonian survey instrument.

OAO-2 also has weathered a budget crisis. Faced with the need to cut back expenses on its worldwide network of tracking and data acquisition "dishes," the National Aeronautics and Space Administration (N.A.S.A.) had proposed to shut down OAO-2 operations last June 30. No less than 40 letters of protest from U.S. astronomers helped N.A.S.A. decide to find the $100,000 or so needed to continue taking data from OAO-2, which now plays host to a number of "guest" observers.

Several elements have been important in the success of OAO-2. Scientists managed to stick with the project for the 10 years it took to get a successful spacecraft in orbit. They managed to get the survey and spectral work done that they had planned while responding to "targets of opportunity" such as a supernova and two comets and opening the instrument to visiting investigators in the manner of national observatories on the ground. The findings about individual stars as well as the blocking of light from them are bound to affect ideas about the formation and evolution of stars. The ultraviolet window on the universe seems to have been thrown open wide.

Threats to Scientific Creativity

Such a success has importance beyond the field of astronomy, which shows mankind so many different examples of matter under extreme conditions. It also raises the question of whether the litany of disdain for "big science," so often chanted, really represents the truth. Throughout the 1960's, an era of "big science" projects, there has been increasing bitterness among scientists themselves about big machines, big money, and big teams of scientists, engineers, and technicians.

The cumulative effects of the scientists' complaints, allied with their cries that science was paying insufficient heed to their mundane problems, have done much to dry up vigorous initiatives and thus ironically to threaten the careers of inventive young workers. There is real danger that idealistic scientists, choosing to punish themselves and their nation for mistakes and shortfalls, both observed and imagined, will in fact destroy beautifully sophisticated, valuable activities in which America has taken the lead.

"Big science" represented vast changes from the supposed tranquillity of small-scale university research before World War II, when the number of scientists in the U.S. may have been only one-twentieth today's total. Budgets swelled to unimagined size. They had to be argued before legislators and executives who did not—perhaps could not—understand the scientific details. As the enterprise of science grew larger and more expensive—and more demonstrably linked to national interests like employment, defense, health, and cleaning up the environment—scientists found that they had to try to explain what was going on to the general public, too. And as public involvement increased, so did public hysteria—over phosphates and mercury, for example. So in the end many scientists came to associate "big science" with annoyances for which they had no patience, remembering fondly the simpler days.

And the game plan changed. It took a long time to get a "big science" experiment ready, and there was always the possibility that in the interim some bright people might figure out a cheaper, quicker way to get results on the same topic. There was also the risk of sudden, total loss—a rocket failure, for example—destroying all the scientific effort. And there was always the chance, too, that the project would be so expensive that no money would be left over to run it properly after the first year, or to add new experiments to capitalize on successes of the first research. Scientists had never before been players in so risky a game.

Fears like these doubtless fed the widespread doubts among the scientific community about many major scientific proposals, including the OAO's, the giant physics machines built at Stanford University and Batavia, Ill., and perhaps even N.A.S.A.'s space stations.

Not the Villain After All

Does the track record of "big science" in the 14 years since the shock of Sput-

nik I bear out the fears? Not much.

To be sure, there have been foolish episodes. There was the 600-ft. dish to be built with unlimited Defense Department money in some tranquil West Virginia hills, with computer-adjustable aluminum surface plates for listening to faint echoes from Soviet military communications as they bounced back from the moon. This project got as far as $40 million worth of concrete footings because of too much secrecy and was then canceled in 1962 by that champion of cost-effectiveness, Robert S. McNamara.

Another heedless decision of that Klondike era was the plan to press forward with a huge deep-ocean platform for drilling straight through the earth's crust to the Mohorovicic discontinuity. The plan was proclaimed after a single, highly-successful test near Guadeloupe Island off the west coast of Mexico, a test which really illustrated the vast scientific potential of a more modest approach. Congress killed the project because there was no visible ceiling on expenditures.

The death of Project Mohole cleared the track for one of the most productive instances of "big science" to date, the world-ranging cruise of the Glomar Challenger. This ship has been drilling holes in the floors of most major ocean basins. Samples brought up by the Challenger's drill have shown the ocean floor to be no older than 200 million years, a finding that greatly enhances our appreciation of the churning forces within the earth.

Meanwhile, "big physics" machines at Brookhaven, N.Y., and near Geneva, Switzerland, were exploring the forest of subatomic particles, and the two immense "big physics" gambles went ahead to completion: Stanford's two-mile linear electron accelerator, announced in 1959, began work in earnest in 1967; and the circular machine at Batavia, Ill., sent its first protons all the way around its big ring last summer. Both machines are miracles of planning and engineering elegance, well adapted to long research lifetimes and almost certain to produce major insights into matter under extreme conditions.

The two machines seem to be feeding each other, providing results that could sort things out in the subatomic jungle. In 1970 an M.I.T.-Stanford experiment showed the strongest evidence to date of "parton" or "quark" substructures within the proton, and this result has already influenced experiments planned at Batavia.

The secret of success at Stanford and Batavia seems to have been entrusting the building of the machine to single managers of unusual generosity of spirit: Wolfgang Panofsky and Robert Wilson, both of whom seem to have some of the boldness and economy of the explorer, Captain James Cook.

Although Arthur Code of the University of Wisconsin and Robert Davis of the Smithsonian Astrophysical Observatory are less dramatic men than Panofsky and Wilson, they have an important success on their hands. In a time full of dispraise, OAO and a surprisingly balanced and relevant "big science" are something to praise.

European Report

Rex Malik

Data Transmission: The Possible – or the Conventional?

Occasionally, a highly simplified leader in one of Britain's more intellectual public prints, or conversely a just as highly technical article in one of the specialist journals, indicates that the minds of our masters are being exercised by data transmission—or, to put it another way, they are being got at. For we have an argument raging among the initiated, and it is presumed that our masters will fall for the most persuasive voice they hear. The argument concerns what kind of data-transmission facilities the nation should have. It has been going on now, in semi-public, for three years, and its outcome may well have a significant impact on events of the next twenty or thirty.

There are those who wish for more of the same—ever-mounting investment with a standard rate of return—and there are those who think that we have one of those rare opportunities to break out from the conventional wisdom and do something sensible (clearly, I belong to the latter school—I had quite a lot to do with raising the subject matter in the first place.)

Currently, in Britain, all data (apart from a couple of anachronisms which it would be too tiresome to go into, left over from the nineteenth century) are carried over Post Office telephone circuits, whether public switched analog circuits or privately rented high-speed lines. The first difference, then, between us and the U.S.A. is immediately apparent: We are dealing with one nationwide system and one authority. And by the standards that currently prevail (though the bad jokes about our phone system are endless) it is a remarkably good system, coping reasonably well with a rate of demand growth which is expected to double the number of phones in the country within this decade.

It is of course administratively slow, for until a couple of years ago the Post Office was a Civil Service department. The switch to the status of a nationalized corporation with a duty to show a profit proceeds quite slowly—the organization is not yet exactly full of commercial dynamism.

A Many-Skilled Power

The P.O. is, however, a hive of technical excellence across a wide range of technology. For not only does it look after the postal system and the phone system, it is also the national telecommunications authority (corresponding in part to the Federal Communications Commission), and has long been involved in government and defense communications and broadcasting. Unlike Bell, it has little manufacturing capability, but it is—perhaps more important—the specifying authority for anything that accesses the communications network. In the telecommunications area, you can't move without Post Office approval.

All of which makes it a power in the land, and like all long established powers, it combines the ancient and the modern. Still in service in parts of the country are exchanges which would have made Alexander Graham Bell weep. Yet side by side with them we have a microwave network which is not only technically very advanced but also probably unique in being fully integrated nationwide.

This many-headed old creature is now, of course, called upon to serve the needs of the digital computer—the same technical demand which, in the U.S., has resulted in a battle between old and new businesses, rather than between today's and tomorrow's technologies (*see "Communications Carriers: Evolution or Revolution?" by P. M. Walker and S. L. Mathison,* Technology Review *for October/November 1970, pp. 44-55).*

Currently, we have probably some 15,000 computer terminals in service in the country, making use of the existing data-transmission facilities. A Post Office study released in 1969 indicated that the number would grow to about 50,000 by 1974/75, and that we should be near the half-million mark by the early 1980's. Fifteen thousand terminals may not seem very many when set against the 150,000 reputed to be in use in the U.S.A. (though the reality of this figure is disputed by many specialists) but it is for more terminals than are in use in all the rest of Western Europe. The Swedes, though advancing rapidly, as yet transmit little volume. The French are still mainly confined to private lines (which is not as expensive as it might seem, for some 80 per cent of France's computers are within a fifty mile radius of Paris). Brittany, which is developing into a sort of French electronic California—though without the climate—now has a very fast data link to Paris, but the rest of the country's facilities are still somewhat ancient. As for the Germans, much of the traffic is still private-wire, at 50 bits/second, a rate at which it's almost quicker to mail a letter.

The British Post Office, responding to the rather unusual pressures upon it, is now publicly committed to doing something about data transmission. The stated goal is a single network, by the late 1970's, which will use the phone communications facilities but have its own exchanges. But this still doesn't answer the important design questions. There's a straight split: on one side are those who wish to follow conventional circuit-switching telephony practice, and to introduce only one major change, namely digital transmission (with pulse-code modulation) as opposed to analog signals; on the other, the advocates of packet switching (plus, again, digital transmission and pulse-code modulation).

Packet Switching

The first type of system is well known,

the second is not. Indeed, the only packet-switched experiment of any size at the present time is that of the Advanced Research Projects Agency (ARPA), of the U.S. Defense Department, which has created a network linking university and other research-center computers on America's east and west coasts. Stripped down to its essentials, the difference between circuit switching (C.S.) and packet switching runs thus:

In the former, links are set up between the calling and receiving points when the call is initiated and accepted. Those links remain in being during the call's duration, and are broken when it ends. In a packet-switched system, the message is first provided with what can best be described as an electronic envelope, of a standard length (the bigger the message, the more envelopes). These standard-length data-packets are then transmitted to a switching point (effectively an exchange) where storage is available. From this point, the packet is routed according to the instructions it carries. It is not like making a telephone call, it is like mailing a letter—routing instructions are carried by the message itself.

In a C.S. system, if the trunk lines are busy or the number engaged, then "engaged" is what you get, even though it may only be those particular direct lines which are overloaded, and though there may be plenty of spare capacity in other parts of the network. In a "store-and-forward" packet-switching system, however, the switching exchanges are all interconnected, and if the direct route is full the system will search out.

The standard packet length makes it possible to change the basis of the charge to the user—to opt for a standard packet charge irrespective of destination, as one does with mail. And a system which can be kept optimally loaded may not require as much investment as would be needed for a conventional C.S. system. Moreover, the users get what they pay for: all that happens as the load builds up is that messages spend longer in storage between moves. There is no need to build in unevenly scattered redundancy, to take care of peak overload conditions on heavy traffic routes, which will be idle most of its life.

There are other possible effects. Such a system has at least two levels: a local network, and the fast data-transmission network proper. The storage and retransmission facilities at the exchanges should enable devices of different speeds to talk to each other across the network.

The origins of packet switching may be of interest. The first serious proposals for a packet-switched network are to be found in Paul Baran's work "On Distributed Communications" which was done at RAND in the early '60's. The proposals were concerned with the creation of a fail-safe defense communications system. Similar ideas were burgeoning elsewhere, though the context was not always the same. One group was at the Computer Sciences Division of Britain's National Physical Laboratory (N.P.L.) under Mr. Donald Davies (once assistant to the late Alan Turing on that early computer project, ACE). Today, the N.P.L. group are the leading protagonists of packet switching and its essential corollary, store-and-forward, outside the United States; indeed, the ARPA work owes much to their thinking and they have collected many allies along the way.

But though the concept has many friends, the number of people who understand the details of store-and-forward packet switching are few. Unfortunately, it is difficult to carry out a realistic experiment on a limited scale, to find out whether it really works before making a huge investment: it is the size that counts (though there is argument even about this.)

The ARPA experiment is encouraging, but the problem in Britain is to convince the bureaucracy. The bureaucracy is moving in, though. The C.C.I.T.T., the European gathering of national telecommunication authorities, has recently commissioned a $1.2 million study to see how the market for data transmission is likely to grow and how best it can be served—which is probably going to add a couple of years more to the time it takes to reach a decision.

Of course, the packet-switching store-and-forward system I have described will be familiar in essentials to any student of cybernetics—it uses some well-known fundamental principles. But as anyone who has ever been involved in cybernetics knows, achieving any sort of progress in the outside world can be desperately slow. In Britain, in the data transmission field as in the rest of the computer business, the basic rule remains true: "Things have a tendency to cost more and to take longer." Anyone want to bet?

Special Report

Lucy Sloan

Minerals and the Law of the Sea

Taking minerals from the sea in large quantities may soon be a reality. Despite a complex assortment of legal, technological, and socio-economic problems, many ocean scientists and engineers, in the U.S. and abroad, are allocating more and more of their resources to investigating possible sources of ocean minerals—especially manganese nodules and metal-rich hot sea brines. (*See "Ocean Mining" by David B. Brooks and "Alternatives for Ocean Policy" by Norman C. Padelford, both in* Technology Review *for July/August, 1969.)*

The extraction technology will differ for these two mineral resources, but the legal problems are initially the same for any countries involved: To whom do the minerals belong? How should they be governed or regulated? To whom go the rights to work them and the benefits from these workings? Nations hope—but it is far from certain—that international agreement on these questions will be possible at a 1973 United Nations Law of the Sea meeting in Geneva.

The existing United Nations Convention on the Law of the Sea (Geneva, 1958) states that the continental shelf is "the seabed and subsoil of the submarine areas adjacent to the coast but outside of the area of the territorial sea, to a depth of 200 m. *or, beyond that limit, to where the depth of superjacent waters admits the exploitation of the said areas* and to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands. . . ." (Article 1, Convention on the Continental Shelf: emphasis added on the so-called exploitability clause).

This, theoretically, would apply to nearly all manganese deposits. Note that the term *continental shelf* has acquired a legal meaning which bears no simple relation to the geological concept of the same name.

As for the metal-rich brines of the Red Sea, "where the coasts of two states are opposite or adjacent to each other, neither of the two states is entitled, failing agreement between them to the contrary, to extend its territorial sea beyond the median line every point of which is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each state is measured. . . ." (Article 12, Convention on the Territorial Sea and the Contiguous Zone).

But since 1958, ocean technology has advanced so greatly that many nations are contesting these Articles by expanding their territorial seas and by dividing among themselves (usually bilaterally) various areas in which they are interested. Francis Auburn, Faculty of Law, University of Auckland, New Zealand, said recently, "To a large degree, continental shelf areas of interest in the next ten years have already been divided up." Discussing the problem at the University of Rhode Island during the 1971 meeting of the Law of the Sea Institute (L.O.S.I.) in June, he gave as examples the North Sea (West Germany and the Netherlands, West Germany and Denmark), the Persian Gulf (coastal states' claims), Davis Strait—Greenland continental shelf (Canada and Denmark), and the Barents Sea (U.S.S.R. and Norway).

For the United States, it is an unresolved question whether or not the 1958 Convention substantially modified the Truman Proclamation (1945), which placed the edge of the shelf at 600 ft. depth, allowed for negotiation of U.S./foreign conflicts within this limit, and of course had no "exploitability clause." John P. Craven, Dean of Marine Affairs at the University of Hawaii, pointed out at the L.O.S.I. meeting that the U.S. Department of the Interior continues to grant leases in waters deeper than 200 meters (i.e., to that undefined exploitability limit included in Article 1). And, he added, "No nation has yet shown any indication of a desire to exploit the resources of the shelf which appertains to the mainland United States' continental margin—nor is any nation likely to do so."

It is the noncontinental portions of the

United States (e.g., the Hawaiian Archipelago, the Aleutian Chain, the Trust Territories of Micronesia) with their resource potentials quite distinct from those of the continents, Craven said, that could cause difficulties for this country in the possible event of nonagreement at the 1973 United Nations meeting.

Hawaii's developing resources demonstrate some potential problems. For example, Hawaiian manganese deposits have a chemical composition different from those of broad ocean nodules (and perhaps also have more rare elements). M. Morgenstein's and J. Andrews' studies, at the University of Hawaii, on the Kauai Channel manganese nodules should help locate other ferride-rich deposits in the Hawaiian Archipelago.

If these new deposits, like the known ones, are just far enough from the Islands to be in international waters, who has jurisdiction over them, who develops them, who benefits from their development?

These questions about manganese nodule deposits apply to them wherever they are found (which is primarily in the Pacific Ocean). And these are not the only questions. Why develop the nodules at all, is another one.

The Economic Incentive

In what is probably the most pessimistic current view of potential commercial exploitation of the manganese nodules for their nickel, copper, and cobalt contents, P. E. Sorensen and W. J. Mead concluded [in F.L. La Que, "Deep Ocean Mining: Prospects and Anticipated Short-term Benefits," *Pacem in Maribus* (special report on a preliminary conference held in April 1970 in preparation for the P.I.M. convocation at Valletta, Malta, 28 June to 3 July, 1970), Center for the study of Democratic Institutions, Santa Barbara, Calif., June, 1970.] that even if credit for the manganese content were allowed, commercial interests could not expect to profit from the operation.

Other experts, even while taking more optimistic positions on mining the nodules for one or more of the minor constituents, foresee possible serious economic and social problems. For example, Miller B. Spangler, of the National Planning Association, emphasized that at least for some of the metals, we could create serious problems of oversupply "because the content ratios of exploitable metals in the deep sea nodules are quite different from the United States' or world's consumption ratios."

Penetrating the metals markets with the nodules too quickly could lead to unemployment in—and reduced taxes from —U.S. mining communities, as well as financial difficulties abroad for certain countries from whom the United States imports various metals and with whom it has foreign assistance programs (e.g., India, Brazil, several African countries). Still other problems could involve national security considerations, conservation, and antipollution requirements.

Metallurgist F. L. LaQue examined the prospects and short-term benefits of deep ocean mining and reached a number of conclusions. Among these: commercial-scale exploitation of deep ocean nodules will probably not happen before 1985. Revenue from exploitation of the nodules will likely be so small in the foreseeable future that it will have no significant effect on the recipients' relative or absolute prosperity. What revenue there is could well have a larger impact on the distribution of prosperity among developing countries than on the comparative positions of developing and developed countries.

He feels that major international emphasis should thus be on encouraging exploration and preliminary exploitation, not on the question of the disposition of revenues, and that developing countries should not anticipate that exploitation would provide a large part of the income they will need for their future developments.

But what keeps drawing both developed and developing countries to the possibilities of mining the nodules is what Herbert D. Dreschler, Krumb School of Mines, Columbia University, calls perspective on the present value of subsea mineral resources. At the 1971 L.O.S.I. meeting he said, "the present value of most subsea mineral stocks is very small —close to zero . . . the value of these stocks may be rising rapidly . . . the cost of owning or controlling the seabed resources is smaller than the value of the deposits; therefore there is economic advantage to acquiring them." And then to trying to exploit them.

Of that "exploitability clause" in Article 1, Eugene B. Skolnikoff, Chairman, M.I.T. Department of Political Science, said, "In other words, if you have the technology to go deeper, it is yours." Many companies feel they do, and they are trying.

One of the most dramatic efforts is that of Deepsea Ventures, Inc., Gloucester Point, Va. They have a pilot plant which they claim has operated almost faultlessly from its recent beginning, to yield from twenty tons of nodules—dredged from 14,900 feet in the Pacific—98 per cent of their assayed content.

They claim that if their plant were scaled up to handle one million tons per year, the operation would be highly profitable at current demands and prices. They are now planning to build on the Gulf of Mexico a plant which will process the nodules from a 4,000-square-mile site which *Ocean Industry* (June, 1971) reports that Deepsea has discovered between the continental United States and the Hawaiian Islands.

Kennecott Copper, Metallgesellschaft A.G., International Nickel, a Japanese consortium, and Hughes Tool Company are others with an active interest in prospects of mining manganese nodules.

The Metal-Rich Brines

So far, interest in the metal-rich hot sea brines and sediments in three Red Sea deeps (*see* Hot Brines and Recent Heavy Metal Deposits in the Red Sea, *ed. E. T. Degens and D. A. Ross, reviewed in* Technology Review, *May, 1970, p. 21*) has come from countries, not companies. But with a $2.3 billion in situ estimated value on the upper ten meters of sediments in the Atlantis II Deep alone (J. L. Bischoff and L. T. Manheim), the questions of jurisdiction and exploitation possibilities are becoming increasingly important. David A. Ross, Associate Scientist, Woods Hole Oceanographic Institution, has cautioned that one must pay to recover and to process the metals—which include iron, zinc, copper, lead, and even very small amounts of silver and gold.

The area's economic history for the next few years, he said, will probably be one of complex legal maneuvers. By the terms of the 1958 Geneva Convention, Sudan owns the deposits. But Saudi Arabia claims the entire Red Sea. (The deposits are almost equidistant between Sudan and Saudi Arabia.) Ethiopia only claims the Atlantis II Deep area. And quite recently a Liechtenstein law firm claimed the rights to the deposits on behalf of an unidentified client.

In addition to these legal and economic problems are the formidable technological ones of devising or adapting techniques to extract and to refine the heavy metals from the sediments and from the overlying brines. First, the depths of the Atlantis II and Discovery Deeps are approximately 2,000 meters. Second, the metallurgical processes to separate the various metals will be complicated—basic metallurgical problems the brines and the nodules have in common.

For these reasons exploration, not exploitation, will continue for some time the predominant effort in the Red Sea.

Individual countries—and companies—can continue to work independently to solve the problems of extracting minerals from the sea. But, should there be nonagreement at Geneva in 1973, unresolved legal problems that the United States and the rest of the world will face could affect any or all of their efforts to implement their solutions.

The discoverer's exclusive right to exploit the minerals he has discovered and to have secure tenure while he does so is essential and fundamental to efficient mining practice, insists George A. Doumani, Science Policy Research Division, Library of Congress, in a report to the House Committee on Foreign Affairs. A legal regime and international agreements must exist, he says, before the mining industry can afford to venture into the sea.

In the absence of these, the United States and other countries will have to evolve independent unilateral, bilateral, and multilateral agreements for each contestable region.

If the lack of an internationally agreed framework persists, Craven said, the United States when it asserts a unilateral jurisdictional claim should also assert a doctrine, so other nations will know which of their possible assertions the United States will accept and which it will reject. He suggested legal testing in each case where law conflicts with United States' interest, because de facto recognition can become customary law.

One example of such a test would be the United States' asserting and maintaining by legal means its resources-oriented jurisdictional claims for its major archipelago and island complexes, to assure that de facto recognition does become acceptable customary law.

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that come through improved efficiency. At present, f
example, a slowdown of even one knot because of botto
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GUESTS" ON THIS BOAT.

The new hull is a time-proven marine alloy of copper and nickel. It's the copper, really, that's anathema to the barnacles. The 10 percent of nickel is there to make the metal easier to weld and form, to give it the necessary strength, and to help protect it from pitting and corrosion.

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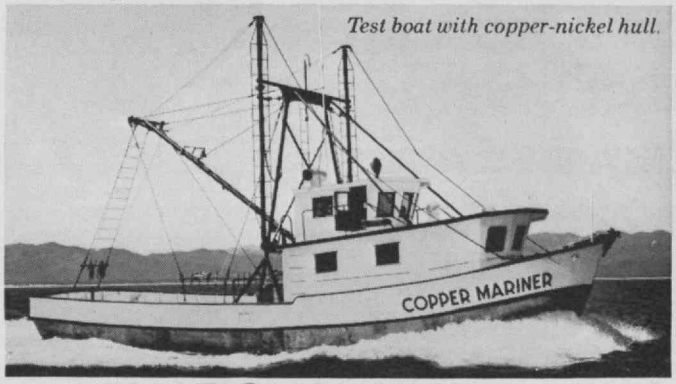

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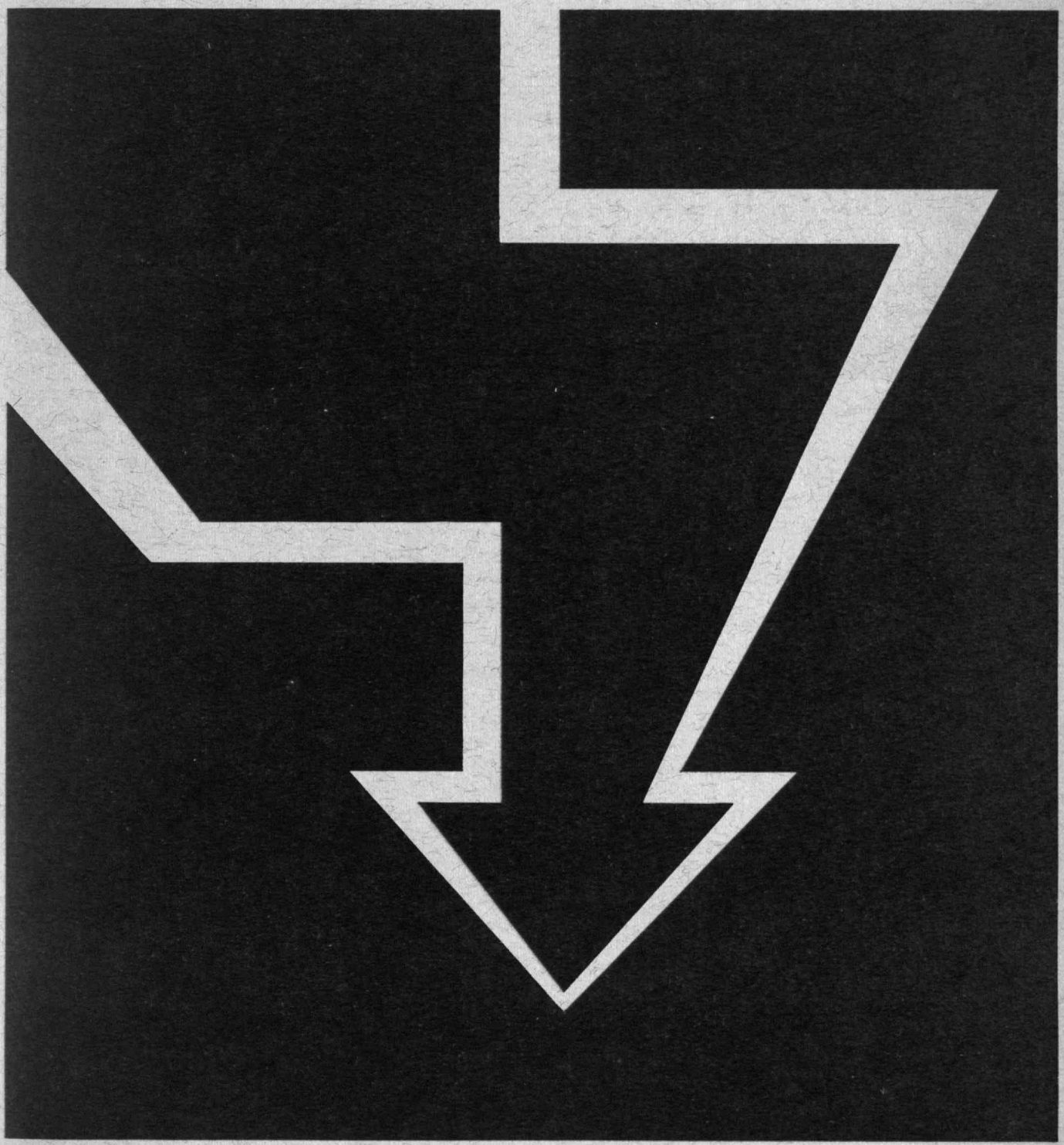
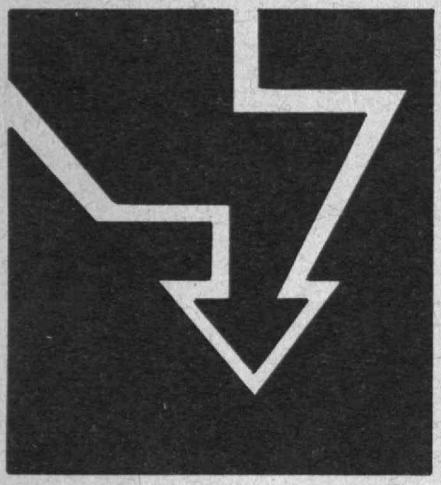


by David C. White
Ford Professor
of Engineering, M.I.T.

Energy, the Economy, and the Environment



Energy has long been viewed as the essential resource to stimulate and support economic growth. It is no coincidence that the U.S., with the world's greatest economic power and highest standard of living, is also the world leader in energy consumption. Today the U.S. uses over one-third of the world's energy; the annual per capita consumption—approximately 3.3×10^8 B.t.u.—is the highest in the world.

Indeed, U.S. energy consumption has been growing exponentially throughout most of the nation's history. Though we have recognized that no finite system can maintain exponential growth forever, we have yet to determine how, when, and why the growth in energy consumption will slow or stop. While energy use today is not necessarily reaching an absolute maximum, there clearly is need for careful study of a wide range of factors inherent in our way of life and in our energy-use patterns.

Changing Energy Requirements and Sources

The energy industry of the United States has achieved an average annual growth rate of approximately 3 per cent for over a century. Expressed in per capita terms, energy use grew from an average annual increment of 1.2 per cent for 50 years beginning in 1880, to an average annual increment of 2 per cent for the next 30 years to an annual average of 2.7 per cent for the last decade, and to a 4.9 per cent annual increment in the last five years. Energy use per dollar of gross national product (expressed in constant dollars), which had decreased slowly since 1920, has been increasing since 1967.

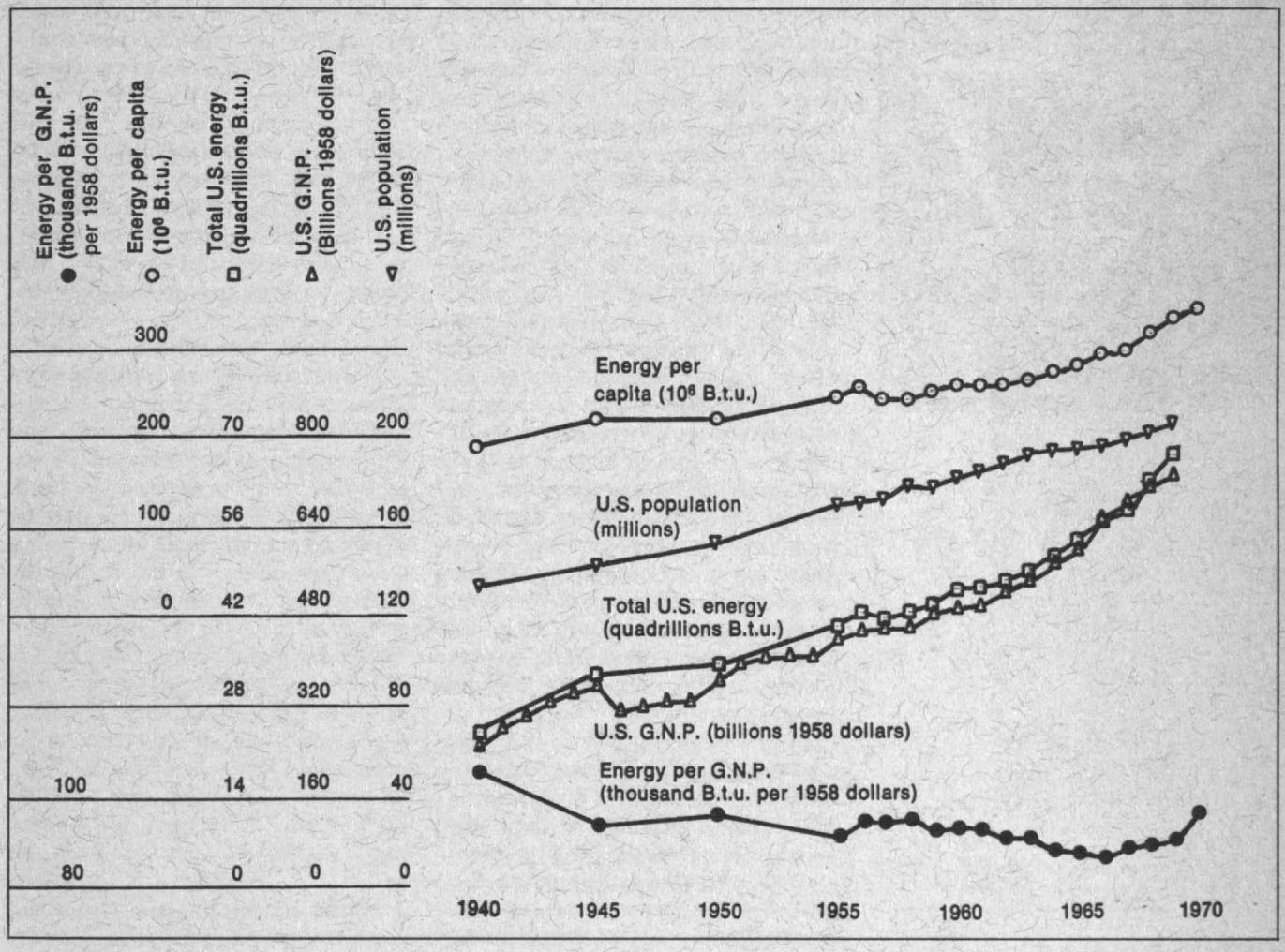
The long-term growing demand for energy has been accompanied by major shifts in primary fuel usage. Wood was the major fuel in the middle 1800's; this shifted to coal in the late 1800's and early 1900's and to oil and natural gas by the mid-1900's, and these fuels are expected to be the dominant energy source into the early 2000's. The primary markets for fuels are also shifting rapidly; by 1980 electric utilities will move to first position among the four primary markets (industrial-commercial, transportation, electric utilities, and residential) for energy. The growing total energy demand, the increasing shift to electricity, the finite supply of our consumable fossil fuels—particularly domestic natural gas and petroleum—and the emerging use of nuclear fuels suggest that further shifts in primary energy fuels and markets will occur in the future.

On the average, the performance of the energy system in the last century—as judged by its ability to supply all energy demands at an acceptable price and thus to stimulate economic growth—has been excellent. But today there are a growing number of factors which are cause for concern; the symptoms seem to be found in the localized "crises" experienced by the U.S. energy supply system throughout the 1960's, which have grown in frequency and seriousness in the last few years. The basic causes have to do with environmental issues and the absolute size and continued high growth rate demanded of the industry—two interrelated effects which have combined in the last decade to disturb the energy supply system.

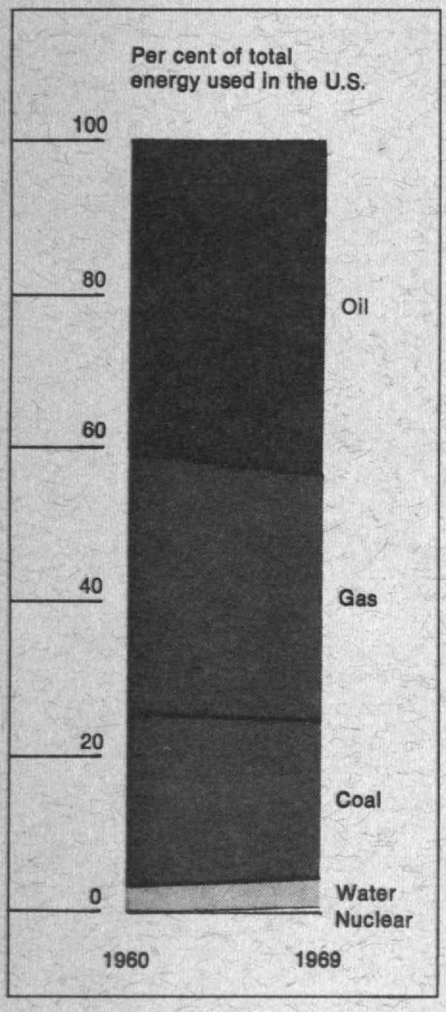
Environmental Factors

The many new environmental qual-

Here is a program to better understand—and perhaps thereby begin to resolve—the complex dilemmas which even with our present primitive insight we begin to observe in our demand for ever-increasing amounts of energy.



Since 1850 the U.S. energy industry has maintained a 3-per-cent average annual growth rate. But in the last half of the twentieth century the curve has been steepening—4.2 per cent in the 1960's, 5.1 per cent in 1969. Even the energy consumption per unit of gross national product has advanced sharply in the last years of the 1960's. The web of issues which determine these trends remain little understood.



Our use of energy is not calculated to make the problems of supply, demand, and resources simpler. In the last decade oil and gas—the fossil fuels in shortest supply—have become increasingly important as energy sources, while coal has comparatively lost ground. Water power and nuclear sources remain insignificant in their contribution to total U.S. energy consumption.

ity standards forced by increasing concern over environmental deterioration are the currently dominant disturbance to the energy supply system. New emission standards on automobiles are affecting the design of engine exhaust systems, changing the additives in fuels, and eventually will lead to major modifications in automobile engines (*see "How Clean a Car?" by John B. Heywood in* Technology Review *for June, 1971, pp. 20-29*). The thermal, particulate, and gaseous emissions from electric power plants are coming under increasing attack, leading to limitations on the thermal rise of cooling water and on the amounts of particulates and other pollutants in stack gases. Requirements designed to maintain general environmental quality are placing major constraints on mining operations, off-shore oil drilling, nuclear waste disposal, electric power plant and power transmission line siting, gas and oil pipelines, and oil tanker shipping.

Energy suppliers now must not merely deliver energy at a competitive price; they must do so while giving major attention to how the energy system affects the environment. Responsible bodies in government and industry are joining concerned citizens to propose that the total cost of energy must include—in addition to the normal costs related to resource utilization, conversion and processing, and delivery—the abnormal costs of environmental degradation, including resource depletion for future generations.

In his "energy message" of June 4, 1971, President Richard M. Nixon stressed the need to use energy more efficiently, saying that "one reason we use energy so lavishly today is that the price of that energy does not include all the social costs of producing it." The historical practice of pricing energy to maximize consumption may no longer be compatible with other factors in our way of life.

Energy Use Patterns and Their Effects

Another measure of our potential problem and its complexity is found in the patterns of U.S. energy use and fuel consumption. In 1960, 20 per cent of our total energy was required for transportation, 21 per cent for electricity, and 48 per cent for heat; and the remaining 11 per cent was devoted to chemical and other non-energy uses. By 1970 both electricity and transportation had increased to consume approximately 25 per cent each. Today the major needs for energy are essentially 40 per cent for direct heat use and 25 per cent each for electricity and transportation.

In 1970 nearly all this energy came from fossil fuel. That is, 90 per cent of the fossil fuel available was used to fuel heat sources or in heat engines; only 10 per cent was used for the intrinsic chemical value of the fuel.

The Problems of Size and Growth

Fossil fuel consumption should theoretically have a very high degree of substitutability—that is, it should be possible to easily substitute one prime energy source for another, since it is the heat content of the fuel that is used. But convenience and economic factors have combined to reduce this substitutability, until now 60 per cent of our coal is consumed in situations where no other fuel could be used—electric utilities, metallurgical coke, and mining. Forty per cent of our oil is so used—chiefly in transportation

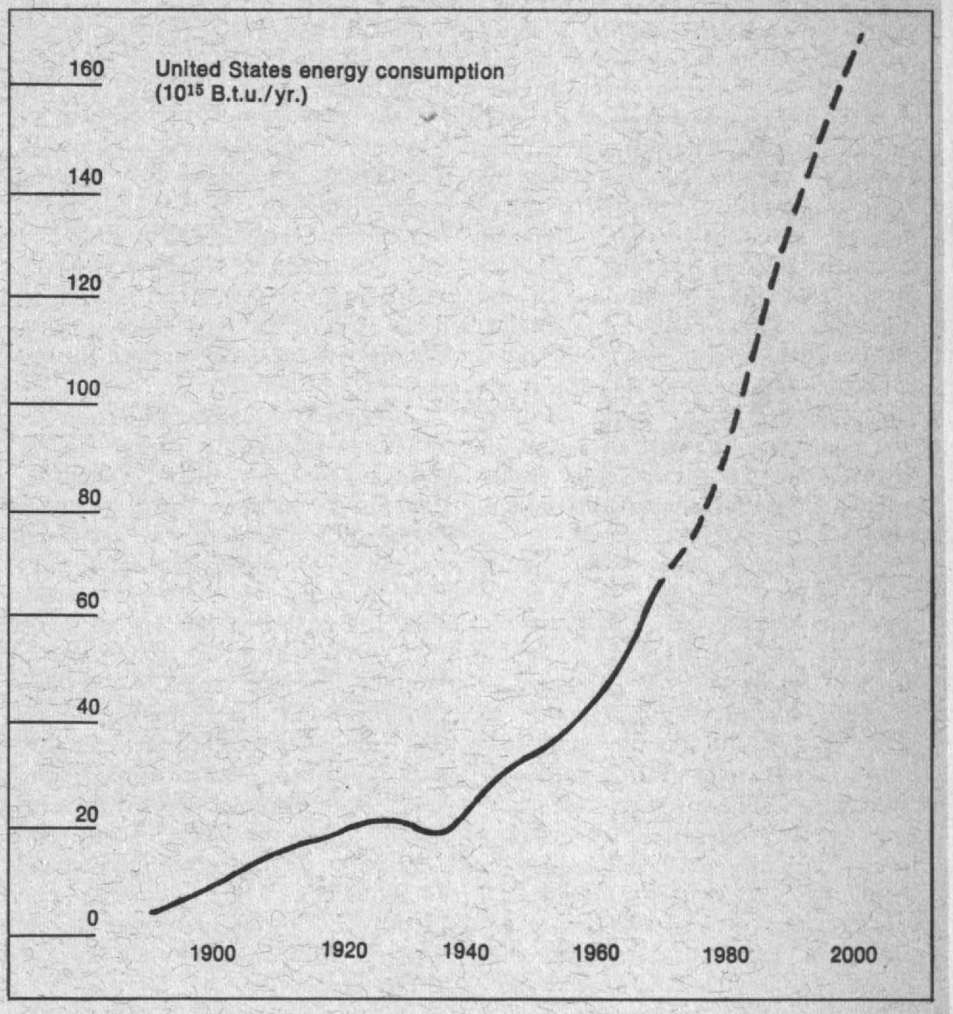
The energy industry of the U.S. has achieved an average annual growth rate of approximately 3 per cent for over a century. In per capita terms this represents an annual increment of 1.2 per cent from 1880 to 1930, 2 per cent to 1960, 2.7 per cent to 1965, and 4.9 per cent for the past five years.

and for lubrication; and 40 per cent of our gas—for field use, space heating, etc. In all, about 43 per cent of our 1969 energy utilization, which is composed essentially all of fossil fuel, is not substitutable, while 57 per cent of the fossil fuel consumed could have been replaced without major technical problems by a different fossil energy source.

A second major influence on the character of the energy system is its size and growth rate. The U.S. energy system's total consumption was 70 x 10^{15} B.t.u. in 1970. The current 9 per cent per year growth rate in electrical demand alone means that electrical capacity must double in less than eight years. To sustain an annual growth rate approaching 10 per cent when the base is so immense requires the development and construction of very-large-scale energy processing and transport equipment. To supply the electric market alone, the Federal Power Commission projects in the next 20 years the need for 300 electric power plant sites and the construction thereon of 300 generating stations with an average capacity of 3,000 Mw. each. Some 7 million acres of new land will be needed for electric energy transmission, in addition to the 4 million acres now in use.

Assuming a 10° temperature rise in the cooling water for this additional plant capacity—without the use of wet or dry cooling towers—the total water requirement would approximate 5 x 10^{14} gallons per year. This is approximately the annual run-off per year from the 48 contiguous states, and it leads to a total cooling water requirement which simply cannot be available for all the projected new plants in the next two decades.

U.S. dependence on imported liq-



In 1960 U.S. energy consumption was 45 x 10^{15} B.t.u. For a century before that, U.S. demand had grown at an average compound rate of 3 per cent a year. But in the last decade the rate has advanced to 4.2 per cent annually, and all estimates propose further future increases. At 3 per cent annual growth, consumption doubles in 23 years; at 4 per cent, 17 years, and at 5 per cent, 14 years.

Even if we can somehow foresee factors limiting the growth rate for energy in the U.S., it is difficult to extrapolate these to world energy consumption. Today, with 6 per cent of world population, the U.S. uses over 35 per cent of world energy production.

uid petroleum is projected by one U.S. company to grow (depending upon government import policy) from its present 25 per cent to 50 per cent by 1985 and to even higher figures thereafter. The demand for natural gas has already exceeded the domestic supply; proven resources have dropped to the lowest point in history (about 12 years), and future growth has been projected at about 2 per cent annually, limited by estimated supply, not by demand. Large reserves of coal and oil shale, sufficient for many years, are available in the U.S., but it is clear that the continued growing use of fossil fuel (a finite resource) must come to an end for some future generation.

The availability of energy from fission sources is substantially more promising. The known deposits of uranium (U_3O_8) recoverable at $5 to $10 per pound are estimated at 22×10^{18} B.t.u. for the U.S. and 60 to 80×10^{18} B.t.u. for the world. If higher costs are permitted, and considering undiscovered deposits, these numbers increase by three or four orders of magnitude (*see "Electric Power from Nuclear Fission," by Manson Benedict, pp. 32-41*). In addition, thorium resources are estimated to be close to those of uranium. Fission fuel resources look substantial even for future generations in the next century—assuming the successful development and economic application of the breeder reactor, which offers much higher fuel efficiency than present water reactors. Without such a development, the relatively extravagant consumption of uranium fuel by water reactors will lead to a fuel resource problem, probably within this century.

The potential availability of energy from the fusion process, if research solves the problem of controlled fusion, is extremely large. The estimated energy in deuterium (D_2) in the world's ocean (7.5×10^{27} B.t.u.) is so large as to appear an almost limitless resource. Lithium, a necessary component of current fusion reactions, is in less supply, but the status of fusion research at this time is not clear enough to make this a major current concern, since other fusion reactions not requiring lithium are possible and of future interest.

But even if a successful fusion reactor resolves the apparent limitations on energy which result from finite fuel resources, there are other factors which jeopardize a sustained growth rate of energy consumption. Even assuming that energy production and consumption can be made completely clean, without particulate or gaseous emissions except possibly water, the fact still remains that almost all consumed energy ends up as heat (the exception is the small amount which is directly converted to chemical form in processing materials or forming chemical compounds). An exponential rate of growth in energy use means an exponential growth rate in heat generated on earth.

The world's present energy use rate is approximately 0.01 per cent of that which the earth absorbs from the sun and reradiates to outer space to maintain its thermal equilibrium. The maintenance of this equilibrium with the sun and space is a very complex question (*see "Climate: The Headline and the Doubt," pp. 6-7*) about which many uncertainties remain. But present knowledge suggests that a delicate balance is involved; heat release on the earth approaching 1 per cent of that absorbed from the sun and reradiated to outer space would surely be a major concern, and a 10 per cent heat release to the environment would be intolerable. A 100-fold increase in energy consumption would place the world close to the 1 per cent range, and a 1000-fold increase would yield a heat release into the environment approaching 10 per cent of that received from the sun. Growth in world energy consumption at a 3 per cent annual rate for only 150 years would lead to the 1 per cent range; considering the potential for rapid growth in energy consumption by the underdeveloped nations, a 150-year estimate may be conservative.

Even if population and environmental controls or shifts in energy use patterns eventually serve to limit energy growth, there is still reason for immediate concern for energy resources and their use. The lifetime of energy producing and consuming systems tends to be very long; generating stations are built to serve at least 30 to 50 years, industrial plants 30 to 50 years, homes and office buildings 50 or more years. Though the automobile may be the energy-consuming equipment with the shortest life (approximately 10 years), it represents a transportation system with long-term constraints. It is clear that we have already made some decisions which will have the effect of perpetuating beyond the year 2000 the 3 per cent average growth rate which has prevailed in the U.S. for the last century. Even if we can somehow foresee factors limiting the growth rate for energy in the U.S., it is difficult to extrapolate these to world energy consumption. Today over 35 per cent of world energy consumption occurs in the U.S., having ap-

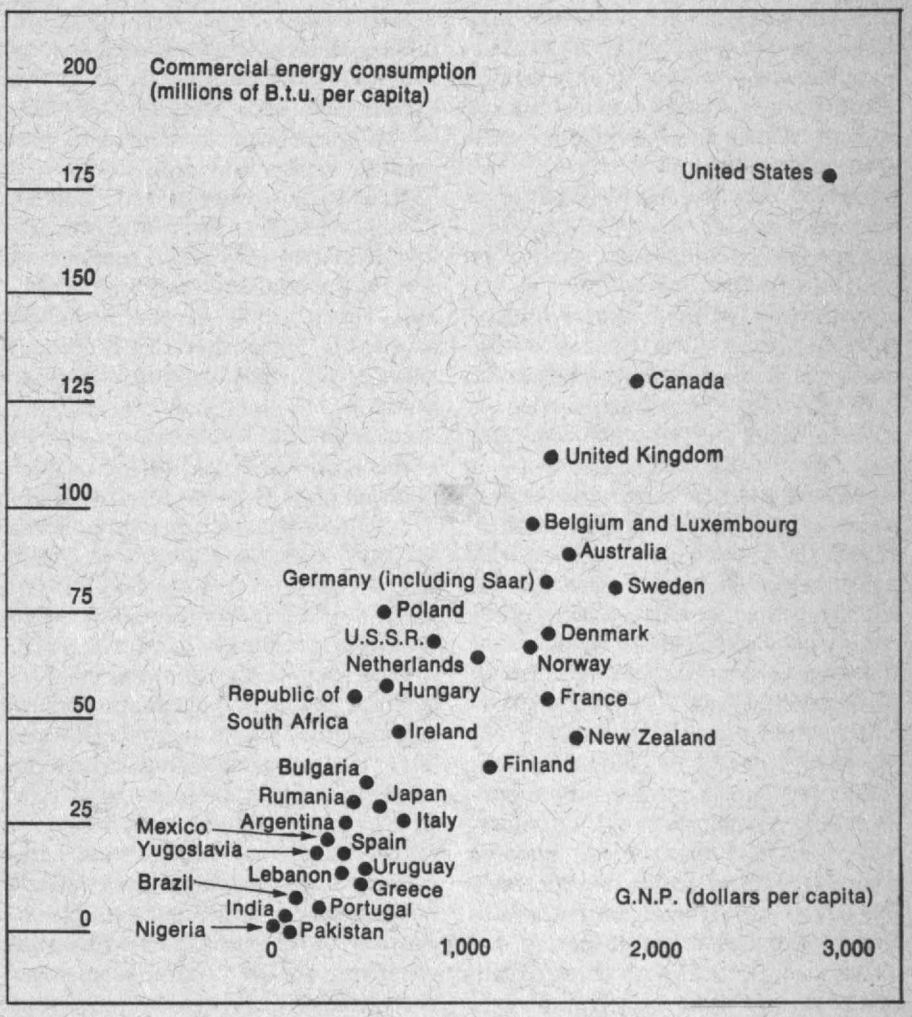
proximately 6 per cent of the world population. Industrialization, mechanization of agriculture, and transportation are all growing rapidly throughout the world from a baseline much lower than that of the U.S., and it is difficult to predict an early decline in the world growth rate for energy.

Should the growth in energy consumption be slowed down? And, if so, how should this be accomplished considering the historic close coupling between economic growth and energy growth?

Characteristics of the Energy System

Changes in our use of energy will involve complex political, social, economic, technological, and environmental issues—all of which must be considered as we attempt to analyze the questions before us. The issues include costs and benefits promised by new technology using available energy fuels, the alternatives involved in the utilization of natural energy resources, the availability and cost of technology for maintaining environmental quality in the face of enormous increases in absolute energy consumption, the energy demand and supply relationships, including the coupling between energy and the economy, and our understanding of the demand elasticity of various components of the economy in relation to the total of gross national product.

The high probability that the world energy growth rate will be maintained or even increased into the last years of the twentieth century and the long lifetimes of energy-consuming plants make clear the need for energy management guidelines to help make policy decisions, set research and development priorities, and assist government in legal



The economic growth of nations and their utilization of energy have been shown consistently to go hand in hand. Today, the U.S.—with 6 per cent of world population—uses 35 per cent of world energy. While the cost of energy is not a large fraction of any nation's gross national product, the availability of energy sources is at least a necessity and probably a stimulant for economic growth. The chart shows 1961 data; by 1970, when U.S. per capita G.N.P. had risen to nearly $5,000, per capita energy consumption was 330 million B.t.u. (Chart: "Energy Research and Development and National Progress," Interdepartmental Energy Study, 1964)

The energy system, complicated by virtue of its tight coupling to the economy, the environment, and the general quality of life, today requires overall modelling studies that include demand and supply dynamics, price elasticities, resource availabilities, environmental factors, and economics. Such a study is today vital for future planning.

and tax decisions at the local, national, and world levels. Decisions are necessary today to materially affect the energy consumption and its distribution among energy sources by 2000.

As the issues of multiplying energy demand and limited energy resources have come increasingly to public attention, there have been many studies of the industry and of national and international trends; updated projections are constantly in preparation by industry and government. Currently the National Science Foundation is sponsoring a series of studies dealing with electric power plant siting, economic modeling of the growing energy demand, the biological and environmental costs of energy use, and other energy-related research topics.

The accumulated effects of growth, size, fuel availability and interchangeability, environmental quality, new technology, changing consumer demand, capital markets, government regulations, and taxes are a complex of factors which make a coordinated and fundamental study of energy supply and demand relationships of major significance.

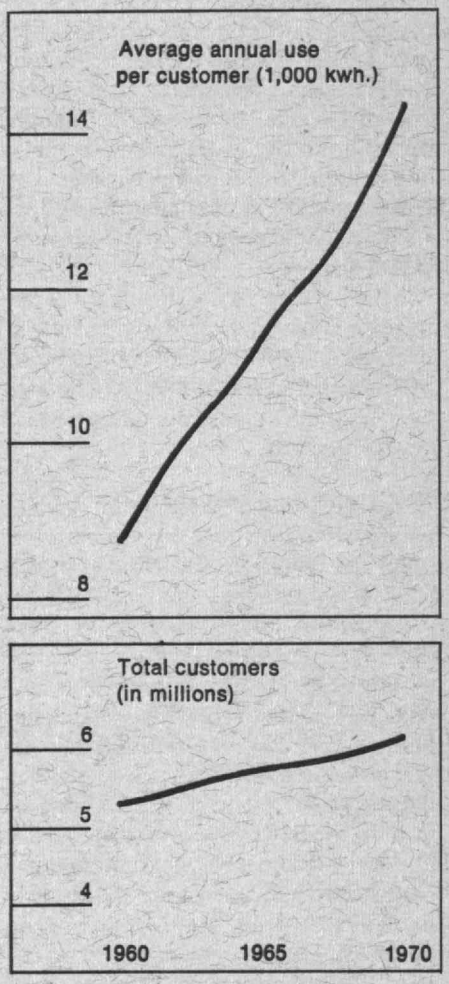
The energy industry is a highly complex and interrelated industry; major time lags necessarily exist in its response to both demand and policy changes. Oscillations in behavior patterns which could be absorbed by interindustry cooperation when the industry was small have become major problems with increases in size. Does the industry in fact have the capability today to respond to changes in demand, technology, and regulation while fulfilling growing needs? For how long in the future can we expect it to do so? Existing studies and projects do not adequately treat this vital question.

Simply using projections to determine probable resource adequacy to fulfill a stable supply system without considering such important factors as environmental control will not meet tomorrow's needs.

Much more attention to policy recommendations and research and development activities necessary to reduce the pressure on the irreplaceable energy fuels in possible short supply is imperative. In addition, greater attention to the absolute limits which the quality of the environment may well set on energy utilization is essential in future predictions of energy usage. The establishment of national energy policies, tax laws, and regulatory practices will depend upon fundamental knowledge of the interactions within the energy system; some form of system modeling will be needed to permit testing and evaluation of alternate policies. An integrated study with the goal of determining demand, supply and institutional relationships is essential.

Most studies of future energy resources and costs completed to date have modeled only single energy industries, giving little attention to other competitive fuel sources and their prices. They tend to ignore the large degree of interfuel substitutability and other industry interactions.

In one typical study Henry Steele proposed that our petroleum energy problems are long-term ones and that price levels will probably have to rise in order to ameliorate them. He presented long-run supply and demand schedules for petroleum crude to 1980, calculating the price levels of petroleum in the Western Hemisphere as related to the amount of imports from Middle Eastern and Pacific sources, concluding that to



The consumption of electric energy in New York State is an example of the steep growth curve: in the decade of the 1960's, power use grew 60 per cent —an average of 6 per cent a year—while the number of customers went up but 1 per cent a year. Noting these figures—and the fact that the utility industry spends less than 0.25 per cent of its revenues on research—the New York State Public Service Commission in its 1970 annual report proposed development of 10- and 20-year plans by the power industry with "realistic target dates" to recognize "ever-lengthening 'lead times' between decisions to build and in-service dates." (Chart: New York State Public Service Commission)

keep Middle Eastern crude down to 10 per cent of total U.S. consumption, prices will have to rise to $3.65/bbl. If the U.S. wants to be completely self-sufficient, he concludes that prices must rise to $5.12/bbl. This study preceded the price increases imposed on Middle Eastern oil in the fall of 1970, and Steele's estimates are now probably too low.

In the demand sector, a typical study is that of Joseph L. Fisher and Carl Kaysen, who built econometric models for electricity demand as a function of price both in the short and long run. They used data from 1946 to 1957 to conclude that:

☐ Short-run household demand for electric energy is influenced by short-run changes in per capita income and that the degree of this influence depends on the "maturity" of the area's economy and also on its degree of urbanization.

☐ Long-run household demand for electric energy seems to be influenced by long-run income, population, and the number of wired households per capita, all of which affect net changes in the use of appliances. The price of electricity seems to have no effect except in cases where the price of gas is low in relation to electricity, in which case the effect is to decrease the use of electric ranges and water heaters. However, if the area is far from saturation in the use of a certain appliance, economic variables as well as demographic ones are of importance in gauging the demand for electricity.

☐ Industrial demand is elastic in the short run. In the case of industries which are intensive users of electric power, the use of electricity per unit of output decreased as energy cost increased; but most industries showed a higher use of electricity per unit of output, perhaps reflecting greater mechanization of tasks.

A markedly different approach has been followed by Jay W. Forrester, Professor of Management at M.I.T., to study interactions in complex societal systems (*see "Counterintuitive Behavior of Social Systems," in* Technology Review *for January, 1971, pp. 52-68*). It is clear that his construction and analysis of complex, nonlinear systems often yield information not easily anticipated by intuitive judgments or by analysis of restricted portions of the total interacting system. The energy system, complicated by virtue of its tight coupling to the economy, the environment, and the general quality of life today, requires overall modeling studies that include demand and supply dynamics, price elasticities, resource availabilities, environmental factors, and economic consequences of change. Such a study—extremely complex—is today vital for future planning.

A Structural Model of the Energy System

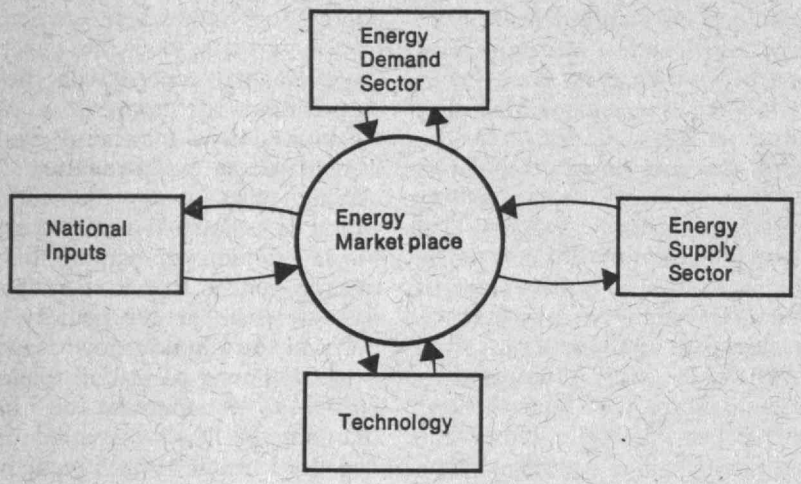
The accompanying figure (following page) shows one model of the general structure of an energy system, influenced by such national inputs as population, gross national product, and investment and other national policy; demand; supply; and technology; and, centrally, by factors in the energy market place. There is extensive feedback between all of these elements, though most of the interaction occurs in the market place. A few comments about each of the five major components of this figure are appropriate, in addition to the general discussion of the preceding pages.

National Inputs

The national inputs to the energy model represent such factors as gross national product, the availability of investment capital, size of population, etc. Two basic sets of macroeconomic relationships must be considered in any energy study.

The first involves relationships—which are clearly not linear—between macroeconomic variables such as gross national product and demands for energy. For example, the projected growth in the American gross national product suggests growth in the demand for energy, but the amount of growth in energy demand is very much dependent on the structure of G.N.P. growth. Different industries have different projected growth rates, and each industry has its own demand for energy. The second set of relationships concerns how the growth of investment —capital equipment—in the energy industry is related to the growth of gross national product. Whereas the first problem relates a growing G.N.P. to a growing need for energy, this relationship is concerned with how limitations in the country's capacity to produce energy can limit the growth of the country's gross national product.

Indeed, energy investment demand is a complicated phenomenon that is just beginning to be understood. Capital-intensive industries such as the public utilities require large capital investments over extended time periods in order to realize increases in capacity. How closely energy investment demand is correlated with aggregate investment demand and other macroeconomic variables, including financial variables such as interest rates and income variables determined by the energy rate structure, is not clear.



Energy Demand Sector:
Industrial processing
Space conditioning—commercial and residential
Transportation (motive power)
Chemical use of fuel
Electric, industrial, commercial, and residential

National inputs:
Gross national product
Population
Investment capital
Government policies

Energy Supply Sector:
Petroleum
Natural gas
Coal (and other solid fossil fuels)
Nuclear (uranium, thorium, deuterium, and lithium)
Electric (viewed as a fuel in the marketplace but requires a more primary fuel)
Miscellaneous (geophysical, hydro wood, etc.)

Technology:
Fossil fuel processing, transportation, and combustion
Transportation
Electric systems
Nuclear energy
Waste problems and thermal processes

Though this model of a national energy system seems simple and clear, the author is at pains to point out the complexity of each of the five sectors and of their interrelations. A preliminary energy system structural model which has been developed at M.I.T. to show these interrelationships in bulk detail is shown on p. 28.

It is clear that changes in the structure of the energy industry will affect investment needs. Nuclear power generation, for example, is more capital-intensive than is fossil-fuel generation, and a shift from fossil plants to nuclear plants would require large capital investments even if the energy supply remains constant.

Energy Demand

The energy demand sector in the model will have to describe how the demand for energy, and ultimately the demand for each type of energy, relates to growth and change in the economy, growth of population, changes in the desired quality of life, and the development of new technology. In this category are a series of questions about the demand for each energy type (for example, electricity) as a function of its price, equipment costs (for example, heating units), the cost of alternative energy, resulting pollution, and macroeconomic activity resulting in intermediate and final demand.

Energy Supply

The energy supply sector represents the supply of each type of energy, both today and in the future. It is dependent upon resources and facilities, changing technology, and economic conditions—including factors in land use, equipment delivery, and plant construction that determine the ability of the energy industry to respond to change. New environmental standards are also critical factors in determining energy supply. Dynamics in the supply sector are heavily dependent upon the characteristics of the fuel supply industry; other factors include the lead times in plant construction, the pol-

lution characteristics of natural resources in relation to government requirements, the amount and cost of capital invested, land availability, and modes of industrial organization.

Technology for the Energy System

The technology of the energy system involves an extremely broad range of disciplines and problems: discovery, extraction, processing, transporting, combustion, and waste disposal of the primary fuels—petroleum, natural gas, coal, shale oil, and nuclear material; conversion equipment using these fuels; energy or fuel distribution—including such products as gasoline, fuel oil, piped or bottled gas, coal or coke, nuclear fuel assemblies, and electricity. To consider all possible processes and technological problems in any model study is not feasible, and a list believed to be representative of the major technological issues which will be significant in influencing the energy system currently and in the foreseeable future has been developed; these are factors which to some degree must be considered in formulating supply-and-demand functions.

Energy Market Place

The national inputs, demand, supply, and technology sectors of the model all strongly interact in the market place, and the results from the market place must then be fed back to influence behavior in the other four sectors.

The development of models for the market place is extremely important —and difficult. The institutional and regulatory complexities of the energy industry make the interaction in the market place far more than simply an equilibrium of fixed supply and demand functions. Most of the energy industry does not in fact operate as a free market. For example, public utilities (both electric and gas) are directly regulated, and these industries are subject to changing rate-setting policies that have a changing impact on both demand and supply. Furthermore, if the capacity of a given fuel industry falls below a "minimum" level of demand for the fuel (for example, if there is not enough home heating oil), then artificial rules (for example, rationing) that are independent of cost can be expected.

Studies at M.I.T.: A Preliminary Model

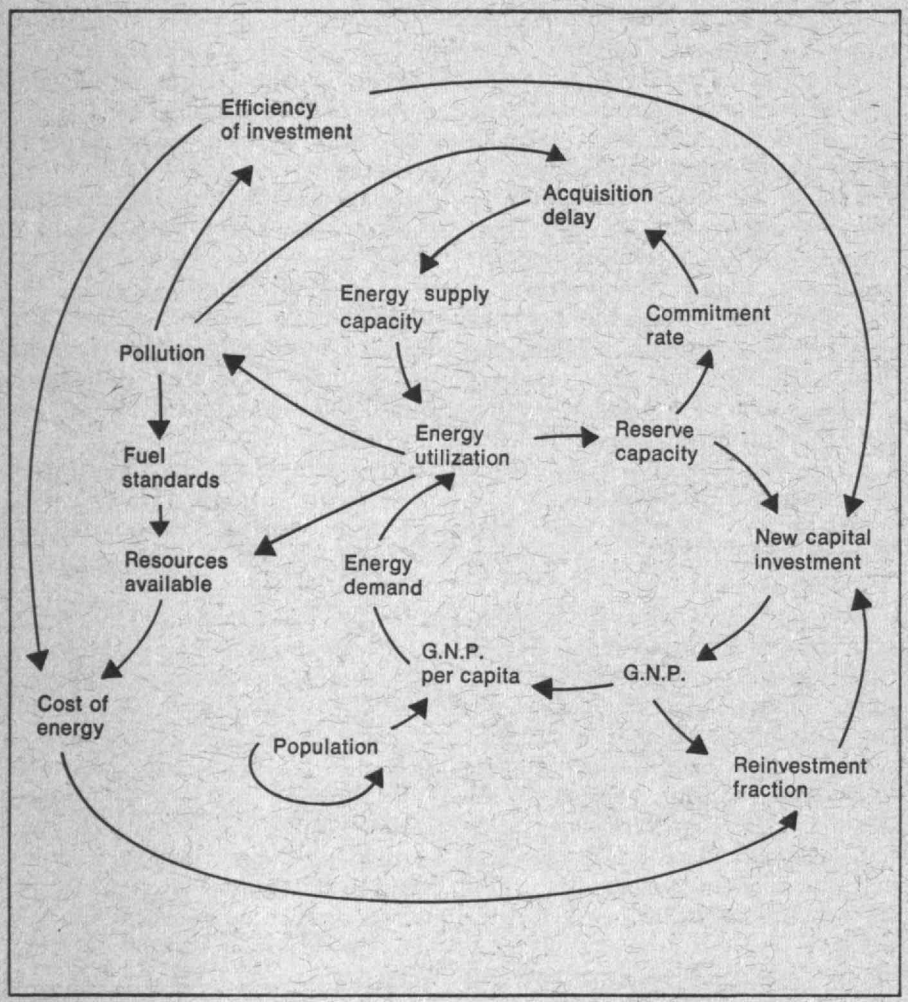
Energy models built along the general pattern discussed above are in early stages of development at M.I.T., and we anticipate extensive computer-based studies of national energy supply problems and alternatives as the project progresses. To date most effort has been devoted to data acquisition, model formulation and model-validation, and general publishable results are not yet available.

However, it may be instructive and appropriate to describe one preliminary model (p. 28) developed by Martin Baughman, a graduate student in the Electrical Engineering Department, which deals with U.S. supply and demand in the aggregate, with no disaggregation for different fuels, for a period of five to 50 years. A model of this sort does not permit an investigation of the effects of interfuel competition or the depletion of any given fuel, but it does provide a framework to study the macroeconomic problems of investment demand, the effects of energy cost as a whole on demand and its growth, and the effects of environmental concerns on the dynamics of energy supply.

The basic drive for energy demand is assumed to be population. It is assumed that energy demand per capita is correlated with gross national product per capita; this has been generally true in fact for the past 40 years in our country. The decision to build new capacity (electric power plants, oil refineries, etc.)—the "commitment rate" in the diagram, p. 28—is assumed to be based on trends in energy demand, the reserve capacity necessary to achieve a reliable supply, and the desired capacity margin for economical operation. However, even after the decision to build new capacity there exists in reality an acquisition delay, composed of siting and construction times, before this capacity is productive. The energy demand then determines the capacity utilization and the amount of reserve capacity. This is the basic supply and demand model.

However, many complex ties between supply and demand exist outside of this basic model. It is assumed that energy is required for growth in G.N.P. and that available reserve capacity affects the rate of new capital investment and G.N.P. growth. For example a shortage in energy supply and energy reserves would decrease the rate of new capital investment. Concern about pollution and other environmental factors cause delays in siting and acquisition.

There are also economic ties from the supply to the demand sector, including, for example, the cost of energy and the investment demand for energy. Changes in these result



The effort at M.I.T. to understand—and eventually simulate—the complex system which governs energy supply and demand has resulted in this preliminary energy system structure. The diagram shows the interrelationships thus far identified; little or no effort has yet been made to quantify the relationships, except to assign relative strengths to parallel relationships for the purpose of preliminary simulations.

Population (lower left) is seen as the driving force; it is assumed to have a direct relationship to gross national product (as population increases, so does G.N.P., and vice versa). A portion of the G.N.P. is devoted to consumption and thus to energy demand, and part goes to reinvestment which results in further growth of G.N.P. Other aspects of the model are discussed by the author in the accompanying text.

from pollution controls, resource availability, and technology. Pollution in turn has been assumed to be related to the rate at which energy is utilized; but pollution abatement equipment raises the capital outlay per unit capacity for the supply sector, and this in turn lowers the pollution generation rate. If capital outlays for new energy resources are large enough, they could affect the capital available for investment in the rest of the economy; therefore energy investment is subtracted from the total of new capital investment in the economy.

The model also proposes that as energy is consumed, the energy resources available at a given price are depleted. Pollution affects fuel standards, which in turn affects the resources available and exploitable at a given price. The ease with which these resources may be exploited—the efficiency of investment in them—affects the cost of energy, and this in turn affects the rate of reinvestment. Here the model assumes that the demand for energy is very inelastic, that consumption is unaffected by moderate—but not drastic—price changes. This suggests that as the cost of energy goes up, for example, the proportion of gross national product devoted to the purchase of energy will go up, and that part of the gross national product available for reinvestment will go down.

In addition to the many variables displayed in the model, there are a number of auxiliary variables and parameters in the energy system that have been introduced into the model but are not discussed here.

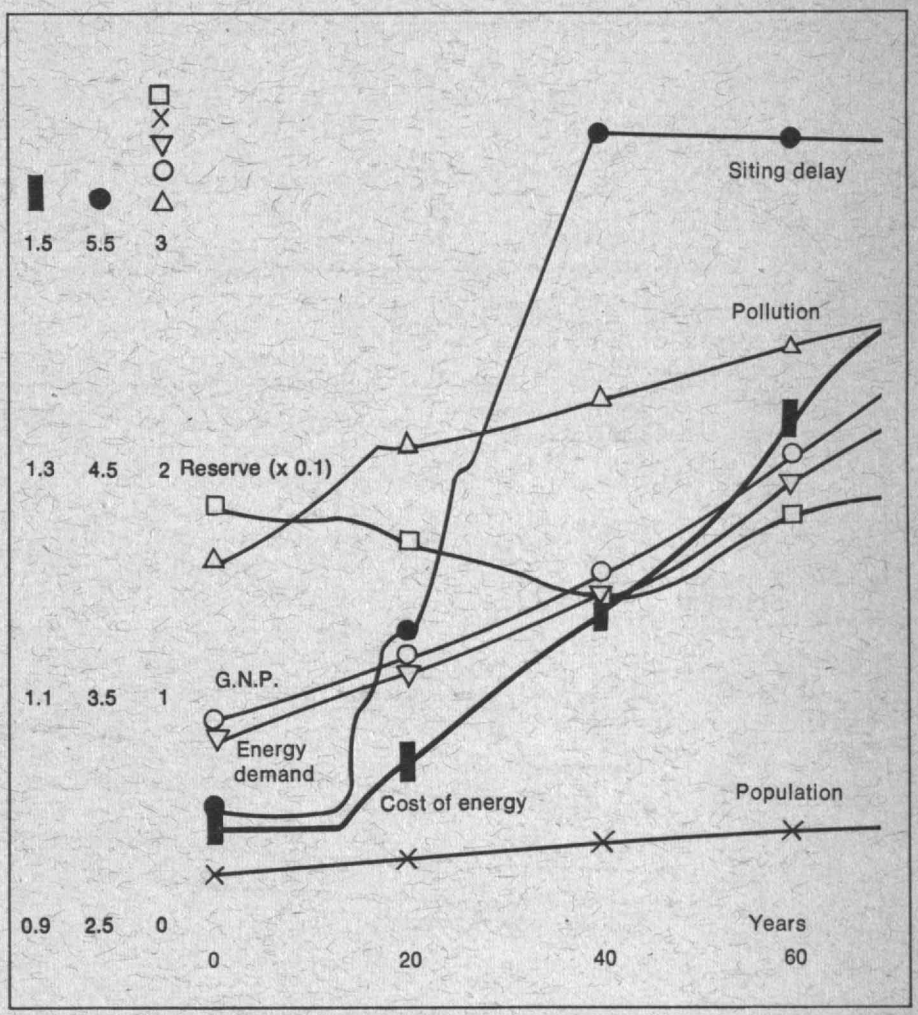
Simulation: Some Numerical Results

The model is used by translating

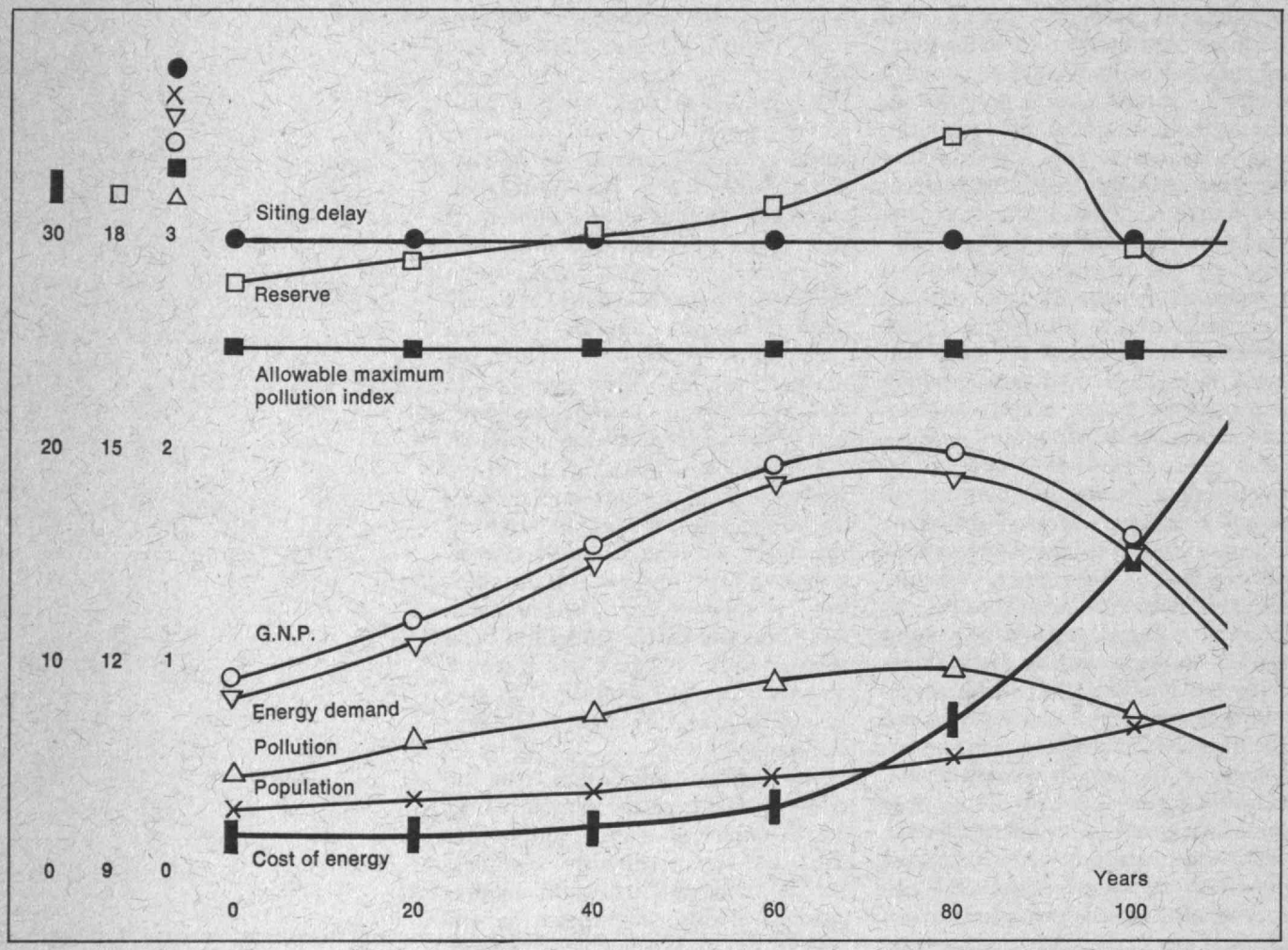
various postulated occurrences into the model parameters, then computing simulations to observe the effects of these occurrences on trends in system behavior and the relationships between variables. For example, it is possible to postulate various technological developments by changing the efficiency of investment or the amount of resources available at a given price.

In one example, population is assumed to grow at 1.1 per cent per year and gross national product nominally at 4 per cent per year, subject to changes through the interactions of investment with other quantities in the model; the desired capacity reserve is set at 18 per cent. Nominal planning and siting delays are specified as three years, and construction time is held constant at four years. If rising pollution is postulated to increase the acquisition delay and decrease the efficiency of investment through the added cost of antipollution devices, the reserve capacity slips down from 18 per cent to about 15 per cent in the 25-year period between time index 15 and 40 in the chart (right). The model permits a maximum siting delay of six years; when this reaches its maximum, the reserve suddenly increases and even overshoots, and the natural time constants of the system are so great that the supply sector recovers only after almost 40 years. Note also that increased investment in pollution abatement equipment causes the growth in pollution to slow down after it reaches the allowable maximum pollution index.

A second example (p. 30) corresponding to a condition where resource depletion occurs has also been studied; this situation can be hypothesized if technological devel-



Two simulations have been made at M.I.T. to test the preliminary energy system model shown opposite. The case shown above proposes that within 20 years rising pollution forces a sharp increase in the time required to locate and bring into use new energy production facilities; there is a modest increase in the cost of energy and a modest decrease in reserve capacity. This is to be contrasted with the case on the next page.



The simulation above, a second test of the preliminary energy system shown on poge 28, assumes that energy resources are gradually depleted over an 80-year period; the cost of energy rises steeply and gross national product finally declines. Note that the cost of energy, starting from the same value at year zero, is plotted on markedly different vertical scales in the two charts on this and the previous page.

Two factors stand out in preliminary results: the sluggish response of the energy supply system to demand changes, and the very large increases in energy cost necessary to modify demand. The slow response of the supply system is one reason to be cautious about postulating short-term solutions to energy supply problems.

opments in breeder reactors, coal gasification, and shale oil exploitation do not occur. Pollution is not a factor because fuel is simply insufficient to yield pollution above the allowable limits. It is obvious that the cost of energy rises as resources are depleted. When the cost becomes large enough so that a significant portion of the gross national product is devoted to consumption, including energy consumption, reinvestment becomes so reduced that gross national product stops growing and even begins to decline—an unlikely possibility in view of any recent precedent, but there is no precedent in modern history for resource depletion. Even as growth in energy demand declines, projections of demand by the energy supply industry remain high, and so reserve capacity climbs; only when demand growth shows a marked decline does reserve capacity begin to drop.

Two factors stand out in these two preliminary studies: the sluggish response of the supply system to demand changes, due to the very long time delays in construction; and the very large increases in energy cost necessary to modify demand. The second result needs considerable additional study, because the inelastic demand built into the model may in fact not be valid. The slow response of the supply system, resulting from delays inherent in today's technological and regulatory environment, gives one reason to be cautious about postulating short-term solutions to energy supply problems.

It must be re-emphasized that the model from which these results have come is very preliminary; little meaning is to be attached to the explicit numerical results. But we believe the model goes far to suggest that the method, when perfected, will yield much insight into the energy system.

The model as now used is completely postulatory, and statistical studies are now under way to substitute experience for postulation wherever possible. Unfortunately, it will simply be impossible to remove all postulative aspects. Even though the model described here is highly aggregated, the number of state variables is quite large. When the model is expanded (for example, to include separate models for each fuel), the number of state variables will be even larger. Extensive studies will be needed—and are now beginning—to uncover hierarchical structures, to reduce model dimensions, and to understand instabilities (if they occur). Only when a more comprehensive model has been successfully developed will research on how it can be "controlled" to give desired behavior be appropriate and meaningful.

One explicit conclusion can be safely drawn from the present work: the dynamics of energy supply systems are extraordinarily complex. Yet it is clear that valid models promise additional insight in our search to understand our energy supply systems and to formulate energy policies which meet energy needs, consistent with conserving energy resources and the environment, now and as we can foresee them into the future.

by Manson Benedict
Professor of Nuclear
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Electric Power from Nuclear Fission

An abundant supply of electric energy generated at low cost with minimal adverse environmental effects is essential to civilized society. Generation of electricity by nuclear fission is capable of meeting all three of these requirements—abundant supply, low cost, and minimal environmental effect. But to realize the full potential of the fission reaction for power generation, the U.S. must now commit significant new resources to research and development of the fast breeder reactor, so that this new energy source will become available before we exhaust our supplies of low-cost uranium in fueling conventional fission plants which operate relatively inefficiently on this remarkable fuel.

Limited space does not permit description of all the nuclear fission reactor types which are now under development. Attention is focussed in this paper on light-water and fast breeder reactors, the principal types in use or under development today in the United States. Heavy-water reactors and molten-salt reactors, which may also play a role in the future, are not dealt with.

The type of nuclear reactor used throughout the world today for electric power generation obtains most of its energy from slow neutron fission of the scarce isotope of uranium, uranium-235, which occurs in natural uranium only to the extent of one part in 140. To obtain the full potential of nuclear energy it will be necessary to develop effective means for utilizing the abundant isotope, uranium-238, which makes up the remaining 99.3 per cent of natural uranium. The most promising type of reactor for this purpose is the fast breeder reactor, in which uranium-238 is converted to plutonium which then undergoes fission with fast neutrons.

The breeder reactor will provide the world with electric energy for thousands of years, far beyond the capability of all fossil fuels—coal, oil, and gas—now known or likely to be discovered. Already nonbreeding reactors in operation in many parts of the United States and elsewhere in the world are generating electricity at a cost as low as that of electricity from fossil fuels in the same place. Breeder reactors, under development in many countries, are likely to generate electricity at an equally low cost.

Light-Water Reactors

The power reactors used predominantly in the United States are of the light-water type. In these reactors, ordinary water, under pressure and at temperatures up to 600° F., is used both as coolant to transport the heat released in fission of uranium-235 and as moderator to slow down the fast neutrons initially produced in fission. There are two principal types of light-water reactor—the pressurized water reactor, used in around 60 per cent of the light-water reactor installations, and the boiling-water reactor, used in about 40 per cent. Both were developed initially in the United States through the joint efforts of industry and government, and their use throughout the world today has reduced the cost of electricity and paid important dividends in enhanced U.S. prestige and favorable foreign trade balances.

The Pressurized Water Reactor

The pressurized water nuclear power plant is so called because the primary water flowing through the reactor is pressurized to 2,250 lbs./sq. in. so that its boiling point is well

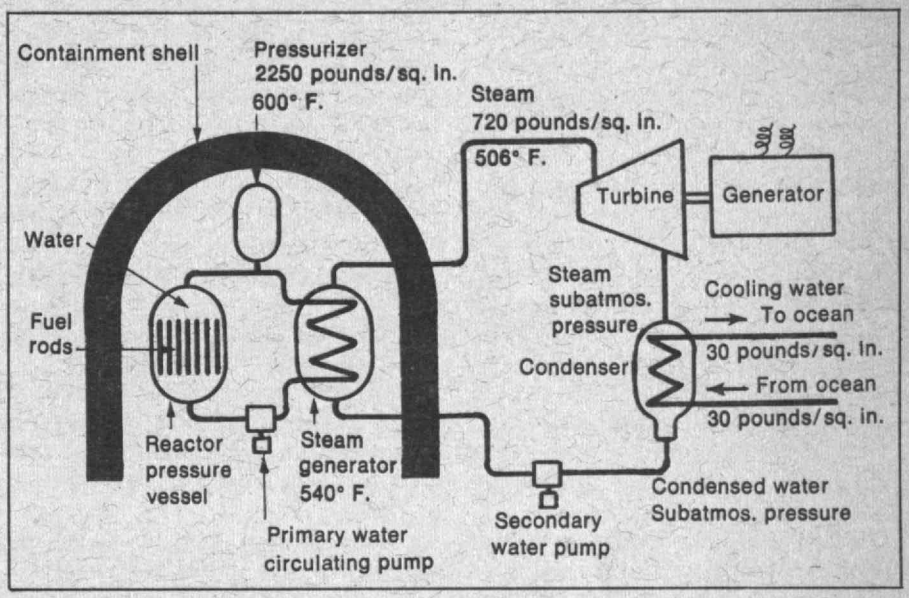
Water-cooled nuclear reactors, inefficient in their use of uranium, are a major factor in our energy supply. But breeder reactors —without which our uranium resources will be rapidly depleted— offer practically unlimited energy for thousands of years.

above 600°F. Fuel rods for this reactor consist of uranium dioxide enriched to about 3 per cent in uranium-235, hermetically sealed in tubes of a zirconium alloy. This zirconium tubing constitutes the first barrier against escape of the highly radioactive fission products which form in the fuel as the end product of the nuclear reaction.

Assemblies of these zirconium-clad fuel rods are mounted in a heavy-walled steel pressure vessel and are surrounded by the pressurized flowing water, which enters at a temperature of around 540° F. and leaves at around 600° F. The water has the effect of slowing down neutrons produced in fission, thus increasing their probability of reacting with uranium-235 to such an extent that the uranium fuel constitutes a critical mass capable of sustaining a nuclear fission chain reaction. To hold the chain reaction at a steady rate, a variable amount of neutron-absorbing boron is used in the reactor, partly as movable control rods and partly as boric acid dissolved in the water.

Pressurized water is pumped through the reactor by the circulating pump, past the gas-cushioned pressurizer which holds the pressure constant, and through the steam generator. There heat is transferred from the primary pressurized water at 600°F. and 2,250 lbs./sq. in. to the secondary water, boiling at a lower pressure of around 720 lbs./sq.in. to make steam at around 506° F. The steam flows through a turbine driving an electric generator and then passes to the condenser where it is condensed at subatmospheric pressure. The condensate is returned to the steam generator by the condensate pump.

In the condenser, heat from the



The pressurized-water nuclear reactor is so called because its primary water system, whose water serves to moderate the reactor as well as transport heat, is operated at 2,250 lbs./sq./in., where the boiling point is above 600° F. Heat is carried by this primary water from the reactor to a steam generator, where it is transferred to the secondary water system pressurized to boil at just over 500° F. Steam in this system drives a conventional turbine and through that a generator, then is condensed and recirculated to the reactor's steam generator. Because operating temperatures of the secondary water system are much lower than the 1,000° F. which can be achieved in modern fossil-fueled plants, thermal efficiency is far less—and heat disposal from the condenser to the environment per unit of useful energy is higher. Both primary and secondary water systems are closed, and there are elaborate precautions against the escape of radioactivity from reactor to the environment.

condensing steam is transferred through cooling coils to cooling water at a pressure above atmospheric, which leaves the condenser at a temperature typically 20° F. warmer than the incoming water. In some plants this cooling water is drawn from natural sources, such as the ocean; in others it is recirculated through cooling towers.

Disposal of the heat contained in this warm water without adverse effect on the environment is one of the problems of all steam-electric plants, nuclear as well as fossil. But because of its relatively low steam temperature of 506° F. compared to the 1000°-F. steam typical of a modern fossil-fueled plant, a water-cooled nuclear plant achieves a thermal efficiency of only 32.5 per cent, compared with over 40 per cent obtainable from fossil-fueled plants. Thus some 50 per cent more warm water must be handled from a nuclear plant than from a conventional fossil-fueled plant of equivalent capacity; this can be dealt with satisfactorily either by siting on a natural body of water with adequate heat-absorption capacity, such as the ocean or a large river, or by use of cooling towers; the cost of heat disposal from a water-cooled nuclear plant is obviously somewhat higher than from a fossil-fueled plant.

A more significant potential environmental problem of a nuclear power plant is the enormous amount of radioactivity contained in it. Accordingly, water-cooled nuclear power reactors are provided with multiple barriers against the escape of radioactivity which have kept releases to insignificant levels, and can be provided with even more elaborate safeguards if these should be required.

Most of the radioactivity is in the form of fission products contained in the uranium dioxide fuel. Some of the fission products are refractory oxides, insoluble in water. Others, however, are volatile or water-soluble, and a small fraction of them appear in the primary water whenever the zirconium tubes leak, as they sometimes do. The primary water also carries corrosion products made radioactive by neutron activation. The radioactive content of the primary water is kept low by continuous purification by filtration and ion exchange, and escape of radioactivity from the primary water is prevented by the leak-tight system within which this water circulates.

Should that system fail and the primary water system unexpectedly leak, there are further barriers against escape of radioactivity. The primary system is completely housed within a steel and concrete containment shell which would prevent escape of serious amounts of radioactivity even if a large fraction of the fission products were to escape from the zirconium tubes.

Any radioactivity leaking through the steam generator from the high-pressure primary side to the lower-pressure secondary side is prevented from further escape by the leak-tightness of the secondary system. Even if the condenser leaked, no radioactivity could inadvertently enter the cooling water and thence be discharged to the environment, because the cooling water is at higher pressure than the steam being condensed.

When the reactor is shut down for refueling and the pressure vessel opened, precautions as stringent as deemed necessary can be taken to concentrate, package, and confine radioactive materials present in the water or pressurized gases.

I have dwelt thus long on the multiple barriers against escape of radioactivity because it is important to realize that, although nuclear power plants contain enormous amounts of radioactivity, release of radioactivity to the environment from them can be controlled to any degree desired —but with increasing cost. All U.S. nuclear power plants are monitored by the U.S. Public Health Service and have been found to add to the environment only a minute fraction of the amount of radioactivity naturally present.

The Boiling Water Reactor

The boiling water reactor differs from the pressurized water reactor mainly in that the primary water in the reactor is held at a lower pressure, around 1,000 lbs./sq.in., and is allowed to boil in the reactor. Steam and water flowing past the fuel are separated, with the water being recirculated and the steam flowing directly to the turbine, after which it is condensed and returned to the reactor. The boiling water reactor needs no separate steam generator, as the reactor itself performs this function. A boiling water power plant has about the same thermal efficiency as a pressurized water plant.

Nuclear and Fossil Plants Compared

At present 17 light-water nuclear power plants, with a total generating capacity of seven million kilowatts, are in operation in the United States; and 108 plants with a total capacity of close to 90 million kilowatts are operating, under construction, or planned. The total capacity of such plants in operation by 1980 is expected to approximate 145 million kilowatts. Why this widespread adoption of light-water reactors in

This table summarizes an analysis by the Virginia Electric and Power Co. comparing various operating parameters and the cost of electricity for a 940,000-kw. station projected for 1974-75 in Fredericksburg, Va., if fueled by fossil (coal) or nuclear fuel. Because of uncertainties, no allowance was made in the projected cost of the fossil-fueled plant ($202/kw.) for sulfur removal from fuel or sulfur dioxide removal from stack gas. The figures are also unbalanced because in actual operation the coal-fired plant would generate slightly less electricity per kilowatt capacity than the nuclear plant. But the company's decision to build pressurized-water nuclear units is obvious.

	Coal	Nuclear
Unit investment cost of plant, dollars/kw.	$202	$255
Annual capital charge rate per year	0.13	0.13
Kilowatt-hours generated per year per kw. capacity	5,256	5,256
Heat rate, million B.t.u./kwh.	0.009	0.0104
Cost of heat from fuel, cents/million B.t.u.	45	18
Cost of electricity, mills/kwh.:		
Plant investment	5.00	6.31
Operation and maintenance	0.30	0.38
Fuel	4.05	1.87
Total	9.35	8.56

competition with conventional fossil-fueled plants?

The first group of reasons relates to the favorable environmental aspects of nuclear power plants. The traffic of fuel into and waste products out of a nuclear plant is negligible compared with a fossil-fueled plant. A 1,000-megawatt fossil-fueled plant consumes over two million tons of fuel per year, but a nuclear plant of the same capacity needs only around 35 tons of uranium dioxide; in contrast to the constant traffic of coal into and ashes out of a coal-fired plant, a nuclear plant needs only one shipment of fuel in and spent fuel out per year. A coal-fired plant needs a large reserve coal pile and noisy coal-handling machinery; a nuclear plant requires only about one-third as much land and is quiet. A fossil-fueled plant discharges an enormous amount of effluent into the atmosphere; a 1,000-Mw. coal-burning plant emits around ten million tons of carbon dioxide per year and several hundred thousand tons of sulfur dioxide, nitrogen oxides, and ash particles, whereas a nuclear plant emits practically none. Because a nuclear plant requires no combustion air it can be built partially or wholly underground if desired, and in any case it can be designed to be less obtrusive aesthetically than a fossil-fueled plant.

Their excellent safety record is another factor which has led to widespread adoption of light-water nuclear power plants. Despite such plants' large inventories of radioactivity, no serious accidents and no overexposure of the general public have occurred in over 100 reactor-years of operation of commercial light-water reactors. Furthermore, another 780 reactor-years of operation without a reactor accident have been recorded by pressurized water reactors in the U.S. Navy.

Another factor favoring nuclear power is its relative invulnerability to interruptions in fuel supply, because a year's supply of fuel is stored right in the reactor. Uranium will be plentiful for at least 20 years, whereas in some places low-cost fossil fuels are already in short supply. The low volume of uranium required permits a nuclear plant to obtain its fuel economically from great distances, whereas a fossil-fueled plant is limited to sources from which transportation costs are low. The cost of electricity from nuclear plants is essentially independent of fuel prices because the cost of fuel is a small fraction of the cost of electricity; and in any case the price of uranium has been stable while the price of fossil fuels has nearly doubled in the past few years.

But all these advantages of nuclear power would not have been effective were it not for the fact that in many parts of the United States and elsewhere, electricity can be generated by light-water nuclear power plants at as low a cost as by other means. This is especially true where the cost of fossil fuel is high because it is not produced nearby—a situation which pertains to most of the United States.

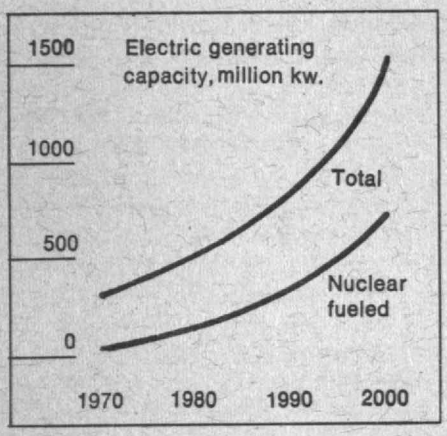
Absolute values for the cost of electricity from different kinds of plants at different times and different places are hard to interpret because of the rapid increases in construction costs and the effects on costs of local climatic and environmental conditions. But one comparison between the cost of electricity from a pressurized-water reactor plant and a plant burning coal will illustrate how nuclear power has been able to compete economically with electricity from coal. Before deciding to build two 940,000-kw. pressurized-water nuclear power units for operation in 1974-75 near Fredericksburg, Va., the Virginia Electric and Power Co. compared the cost of building a nuclear plant and a coal-fired plant of the same size and estimated the cost of heat from nuclear fuel and coal. The unit cost of the nuclear plant was estimated to be $255 per kilowatt and the coal plant $202 per kilowatt. But the nuclear plant showed lower projected fuel cost—18 cents per million B.t.u. compared with 45 cents per million B.t.u. estimated for coal at that place and time. This difference more than offset the capital cost disadvantage of the nuclear plant, and —as shown in the accompanying table—the cost of electricity was predicted to be 8.56 mills per kilowatt hour for the nuclear plant and 9.35 for the coal-fired plant. The coal-fired plant could not be competitive with the nuclear plant unless coal became available at the plant at a price of 36.2¢ per million B.t.u., an unlikely circumstance in view of the recent rapid rise of coal prices.

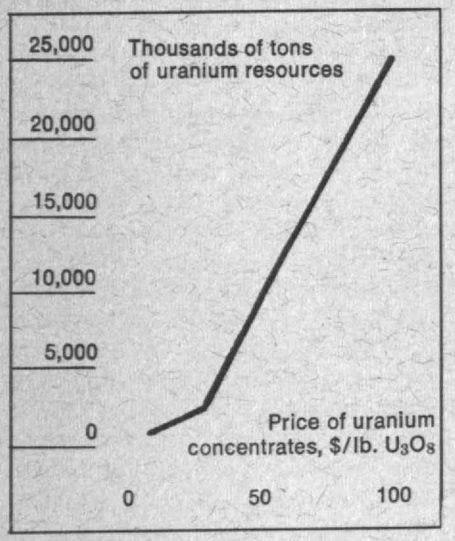
The economic advantages of nuclear power are likely to be even greater where local restrictions require use of low-sulfur coal or oil at costs of 50¢ per million B.t.u. or higher.

Radioactive Wastes

This discussion of light-water reactors would not be complete without mentioning their problems and disadvantages.

One problem which light-water reactors share with all other fission reactors is safe, long-term storage of their highly radioactive fission products. Present procedures are to seal





Current projections show that the U.S. electric generating capacity will rise to 523 million kw. in 1980, 1,550 million kw. in 2000; of this total, 145 million kw. in 1980 and 735 kw. in 2000 will be from nuclear-fueled plants. If these plants are based on water-cooled reactors, they will have required 200,000 tons of uranium concentrates by 1980, 1.6 million tons by 2000. The lower chart shows that, under these conditions, the U.S. will by the year 2000 be forced to use such impoverished uranium ores that the price of uranium concentrates will have more than doubled; and this factor alone will have added 0.4 mills/kwh. to the price of electric energy. (Data: U.S.A.E.C. Report WASH-1098)

spent fuel assemblies removed from the reactor in shielded containers specially designed to withstand shipping accidents. Thus sealed, fuel assemblies are transported to a reprocessing plant where they are cut open, their contents dissolved in acid, their uranium and plutonium recovered, and the radioactive fission products concentrated. These highly radioactive wastes are stored in solution for around five years in double-walled containers. Present regulations of the Atomic Energy Commission require that after five years these solutions be evaporated to dryness and the resulting solid fission products be sealed in steel containers. Finally, these containers are to be shipped to a national radioactive waste repository to be located in a salt mine in central Kansas for storage 1,500 feet underground. This location is chosen because geologic evidence indicates that the radioactive wastes will remain out of contact with ground waters for far more than the 1,000-year period in which they must be safeguarded before their radioactivity will decay to a harmless level.

The technology for shipping and reprocessing radioactive fuel has been developed and proved safe by a number of years of operation, although additional measures for retention of the long-lived gaseous radioactive species tritium and krypton-85 released in reprocessing will be required when the volume of fuel is greater than now.

The proposed storage of radioactive wastes in salt deposits was examined by a committee of the National Academy of Sciences which reported in November, 1970, that "the use of bedded salt for the disposal of radioactive wastes is satisfactory . . . (and) is the safest choice now available, provided the wastes are in an appropriate form and the salt beds meet the necessary design and geological criteria. The site near Lyons, Kansas, selected by the A.E.C. is satisfactory, subject to development of certain additional confirmatory data and evaluation." Despite this favorable report, the widespread concern about this proposal which has recently arisen and the unprecedented responsibility involved in safeguarding highly toxic material for a thousand years dictate thorough test and careful, gradual exploitation of this proposed storage method.

Uranium Consumption of Light-Water Reactors

Two particular disadvantages of light-water reactors are their low thermal efficiency, already mentioned, and—much more significant—the fact that they utilize effectively only the scarce isotope uranium-235. The incomplete use of natural uranium will be a very serious disadvantage unless much greater amounts of uranium are discovered than have now been found. The accompanying chart shows that 145 million kw. of nuclear power are expected to be installed in the U.S. by 1980 and 735 million kw. by 2000. If these are all light-water reactors, the U.S. will require 200,000 tons of uranium concentrates by 1980 and 1.6 million tons by 2000. These figures are to be compared with the total resources of uranium in known deposits and expected to be found in extensions of them as a function of uranium price, shown in the second chart. Unless more uranium is found, the 1.6 million tons which would be consumed to generate 735 million kw. in light-water reactors by the year 2000

Fast breeder reactors could generate much more electricity than light-water reactors from a given amount of uranium, and progressively higher uranium prices would cause essentially no increase in the cost of electricity generated by fast breeder reactors.

Uranium price, $/lb.	U.S. uranium resources, tons	Increase in cost of electricity, mills/kwh.		Million kw.-years of electricity which could be generated	
		Water reactor	Fast breeder	Water reactor	Fast breeder
8	594,000	0.0	0.0	3,470	460,000
10	940,000	0.1	0.0	5,500	720,000
15	1,450,000	0.4	0.0	8,480	1,120,000
30	2,240,000	1.3	0.0	13,100	1,720,000
50	10,000,000	2.5	0.0	58,300	7,700,000
100	25,000,000	5.5	0.0	146,000	19,200,000

would raise the price of uranium from the present value of under $8 per pound to over $15. Since the cost of electricity from light-water reactors increases by about 0.06 mill per kilowatt-hour for each dollar-per-pound increase in the price of uranium, this would add more than 0.4 mill per kilowatt hour to the cost of electricity.

Even more serious, of course, would be the complete exhaustion of all of our presently estimated resources of low-cost uranium in less than 30 years.

Fast Breeder Reactors

The wasteful consumption of low-cost uranium by light-water reactors can be arrested if fast breeder reactors now being developed in many countries prove to be reliable and economic.

The fast breeder reactor is fueled with a mixture of plutonium and abundant uranium-238. A coolant which does not slow neutrons—either helium under pressure or liquid sodium near one atm.—is substituted for water. Fission of a plutonium atom by a fast neutron produces about 2.5 neutrons for every neutron consumed. One of these neutrons continues the fission chain reaction and the remaining 1.5 are absorbed by uranium-238 to produce 1.5 atoms of new plutonium. One of these replaces the plutonium consumed in fission, leaving a net gain of around half an atom of plutonium for every 1.5 atoms of uranium-238 consumed. In this way all the abundant uranium-238 in natural uranium can be used as fuel, multiplying our nuclear fuel resources more than a hundred fold.

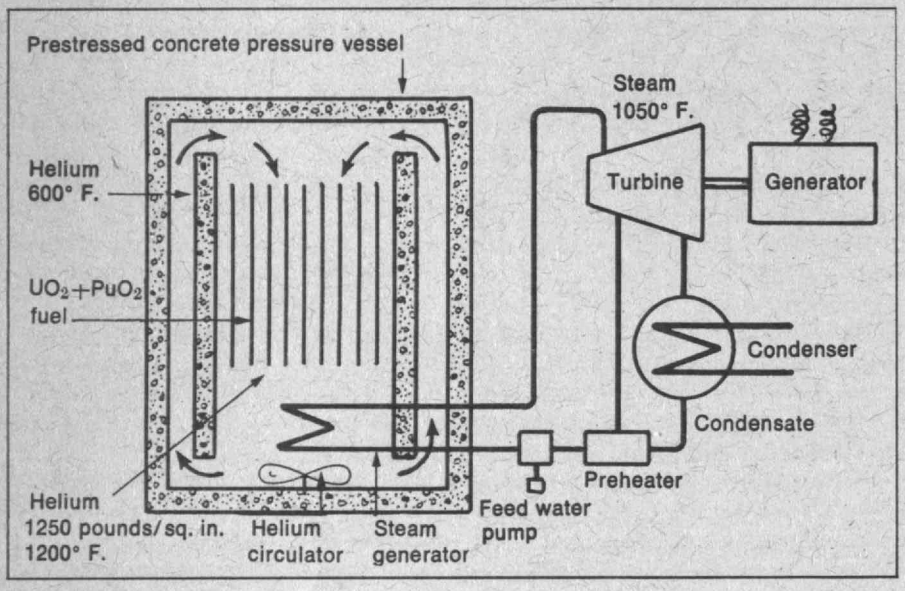
But this is only part of the improvement in our nuclear fuel resources which would be made possible by the breeder reactor. A breeder reactor requires only 1.3 tons of uranium per million kw.-years of electricity produced, compared to the water-cooled reactor's 171 tons. Thus the cost of electricity from a breeder reactor would be practically independent of the price of uranium. Consequently, if the fast breeder reactor proves to be economic at today's uranium price of $8 per pound, it still could be fueled economically with uranium costing $50 or $100 per pound. At $100 per pound U.S. uranium resources are estimated to be 25 million tons, compared with less than 1.5 million at $15 per pound. Thus, by using this high-cost uranium, the breeder reactor would extend nuclear fuel resources by another factor of over 15. For example, as the table shows, light-water reactors could generate 8,480 million kw.-years of electricity from all the uranium available at $15 per pound, about the highest uranium price at which this type can compete with fossil fuel at today's prices. Fast breeders, on the other hand, could generate 19.2 million million kw.-years of electricity from uranium at $100 per pound, more than 2,000 times as much as light water reactors. At the present rate of electric generation in the United States—300 million kw.—fast breeder reactors fueled with U.S. uranium resources available at $100 per pound could provide all our electricity for 64,000 years. It is this tremendous extension of our fuel resources which makes development of the breeder reactor so challenging and important.

Where does development of the fast breeder stand today? Its ability to compete economically with the light-water reactor is not yet proved, but the fact that it would consume so much less natural uranium is a favorable factor which should make the fuel cycle cost of the fast breeder around one mill per kilowatt hour lower than the fuel cost of the light-water reactor. With this advantage, the capital cost of a fast breeder could be as much as $50/kw. higher than a light-water reactor without the breeder losing its economic advantage. Reactor development authorities in this country and abroad believe that a fast breeder need not cost this much more than a light water reactor. I share this hopeful view.

The two types of breeder reactor which have the best chance of meeting this cost requirement and being proved technically sound are the liquid-metal-cooled fast breeder reactor (LMFBR) and the gas-cooled fast breeder reactor (GCFR). The liquid-metal breeder would use molten sodium at low pressure as coolant, whereas the gas-cooled breeder would use helium at 50 to 75 atm. Both would use a mixture of plutonium oxide and natural uranium oxide as fuel, would have a thermal efficiency close to 40 per cent, and would be capable of producing close to 1.5 grams of new plutonium for every gram of plutonium consumed. This high breeding ratio gives these reactor types a tremendous advantage over other types of breeders.

Gas-Cooled Fast Breeder

Development of the gas-cooled fast breeder can draw on the helium-cooled reactor technology already developed for the high-temperature gas-cooled reactor (HTGR). One 45-Mw. example of this slow-neutron, nonbreeding, helium-cooled reactor is now in operation in the United States, and a second 330-



The breeder reactor utilizes fuel composed of plutonium and the abundant 238-isotope of uranium; fission of one plutonium atom by a fast (unmoderated) neutron from the uranium yields 2.5 new neutrons, and one of these continues the fission reaction while the remaining 1.5 are absorbed by the uranium-238 to produce new plutonium to replace that consumed in fission. In the gas-cooled fast reactor, helium gas—inert even at these temperatures—is circulated through the reactor and then across a steam generator to produce steam at over 1,000° F.; this steam in turn drives a turbine connected to a generator, then is cooled in a condenser and returned through a preheater to the steam generator. Because operation is at high temperatures, the overall efficiency may be as high as 40 per cent and the amount of heat to be distributed from condenser to environment per unit of energy produced is relatively low.

Mw. unit is being built. The gas-cooled fast breeder reactor would use fuel consisting of a mixture of 15 per cent plutonium dioxide and 85 per cent uranium-238 dioxide clad in stainless steel; this would be generally similar to fuel developed for the LMFBR. Helium gas at 1,250 lb./sq.in. is pumped by a helium circulator over the fuel and is thus heated to 1200° F. The helium then flows through the steam generator, producing steam at 1050° F. Fuel, helium circulator, and steam generator are all contained within a prestressed concrete pressure vessel. The prestressed-concrete pressure vessel, helium circulator and helium-heated steam generator developed for the HTGR could be used without major change for the gas-cooled fast breeder reactor. Because of the high temperature at which steam is produced, the thermal efficiency of this gas-cooled fast breeder system would be around 40 per cent, much better than water-cooled reactor systems and as high as a modern fossil-fueled plant or the liquid-metal fast breeder system.

The major drawbacks of the gas-cooled fast reactor stem from the relatively poor heat-removal characteristics of helium gas, compared with liquid sodium, and the most serious consequence is the difficulty of preventing overheating of the fuel if in some way the helium loses its pressure. Engineering studies of solutions to this and other problems of the GCFR are being conducted in this country and in Europe, and solutions are likely to be found; but there are as yet no firm plans for building a reactor of this type.

The GCFR is, nevertheless, an attractive concept because it promises high breeding ratio, high thermal efficiency, low capital cost, and

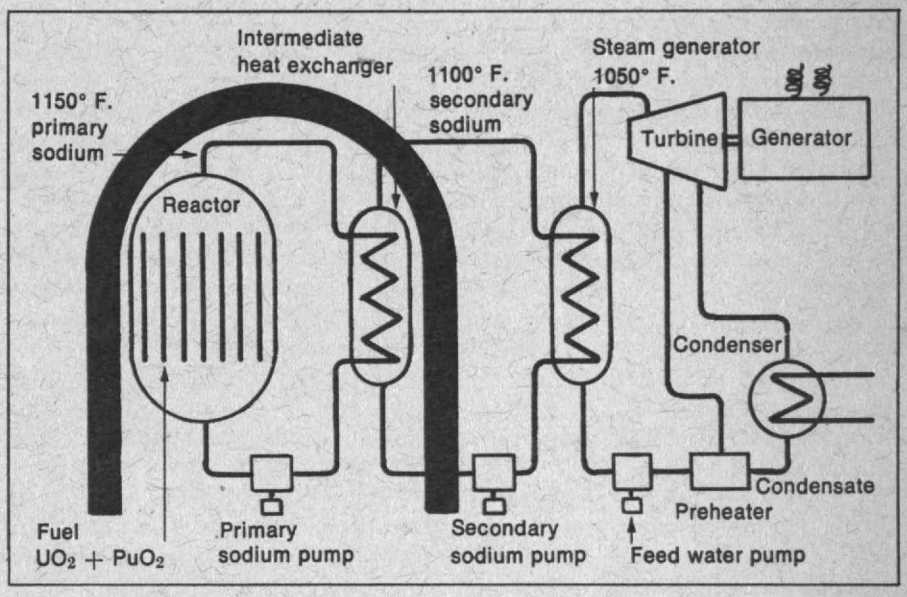
The development of liquid-metal fast breeder reactors is in fact far advanced. Because today's reactors provide only a short-term solution to our electric energy needs, we must move ahead aggressively with breeder reactor development.

freedom from the problems of handling sodium that complicate the liquid metal breeder. Because of its advantages over the liquid-metal breeder, the gas-cooled fast breeder should receive substantially increased development funding.

Liquid-Metal Fast Breeder

The use of sodium as a coolant for fast reactors has appealed to reactor engineers since 1950, and a number of sodium-cooled fast reactors have already been built. Sodium has excellent heat-removal characteristics—very high thermal conductivity and high volumetric heat capacity—and risk of overheating of the fuel during normal operation or in emergencies is practically eliminated. If the reactor is designed as a double-walled vessel with no openings below the top of the fuel, there is full assurance that the fuel will remain submerged in and cooled by liquid sodium even in the event of mechanical failure of the cooling system external to the reactor. Its high boiling point and its compatibility with stainless steel assure that sodium can be heated to 1150° F. in the reactor and then can be used to generate steam at the high temperatures and pressures used in conventional power plants, yielding a thermal efficiency over 40 per cent.

But sodium has numerous drawbacks. It is opaque, so that refueling and other operations in the reactor have to be carried out blind. It is made intensely radioactive in the reactor, so that it is considered prudent to interpose a secondary, nonradioactive sodium coolant loop between the primary reactor sodium and the steam generator, as shown in the diagram. Sodium reacts with air or water, so that it is necessary to provide argon as a cover gas for



In the liquid-metal fast breeder, two sodium systems substitute for the helium in the gas-cooled reactor; sodium is chosen for its high thermal conductivity and heat capacity, which essentially eliminate risk of reactor overheating. Heat from the reactor is moved through the primary (radioactive) sodium system at about 1,150° F. and transferred to the secondary (nonradioactive) sodium system (1,100° F.) in the intermediate heat exchanger. The secondary system in turn provides energy for a steam generator in the water system (1,050° F.) driving conventional turbine and generator; high steam temperatures assure relatively high efficiency and low cooling demand for the water system condenser.

*Six liquid-metal fast breeder power plants generating small amounts of power have been built, and four more are under construction. Though the U.S. took an early lead in these developments, it is clear that the most extensive current activity is centered in Europe. *The dates given for reactors under construction are the year in which first operation is scheduled.*

Reactor		Capacity, megawatts	Years operated
EBR-I	U.S.	0.3	1951-63
Dounreay	U.K.	60	1963-
EBR-II	U.S.	20	1965-
Fermi	U.S.	70	1965-
Rapsodie	France	20	1967-
BR-60	U.S.S.R.	60	1970-
Under construction:			
BR-350	U.S.S.R.	150	1971*
PFR	U.K.	250	1972
Phenix	France	250	1973
BN-600	U.S.S.R.	600	1973-75

all free sodium surfaces and to design the steam generator so that leakage of water into sodium is impossible. The design must also eliminate any chance of local boiling of sodium in the reactor, since this might permit an unacceptable increase in the rate of fission. Finally, a commercial liquid-metal breeder reactor requires the development of pumps, valves, and heat-exchangers for handling sodium in unprecedentedly large volumes.

The technology for resolving these difficulties with sodium is largely available, and the development of liquid-metal fast breeder reactors is in fact far advanced; a number of power plants of this type have been built. Indeed, it was in 1951 that the Experimental Breeder Reactor I demonstrated a breeding ratio greater than unity, and it was the world's first reactor to generate electricity. Later the larger Experimental Breeder Reactor II and the Enrico Fermi Reactor have come into operation. Now Russia, England, and France, although entering the breeder field later than the United States, have run reactors comparable to our Experimental Breeder Reactors, and all three are now building demonstration breeder power plants larger than any now authorized here. Germany is about to embark on construction of a 300-Mw. fast breeder power plant, and Japan and Italy are making rapid progress.

The policy of the U.S. Atomic Energy Commission has been to build facilities for testing the novel components of a liquid-metal fast breeder reactor before constructing any large demonstration power plants. Thus three industrial companies have built testing facilities: General Electric has participated in testing the dynamic and safety characteristics of a small LMFBR; North American Rockwell has built facilities for engineering tests of sodium components; and Westinghouse is building the Fast Test Reactor, to test fuel, scheduled to start operation in 1974. Each of these firms has submitted to the A.E.C. a proposal to build a demonstration LMFBR power plant in the 300- to 500-Mw. range, each of which would cost around $500 million.

A number of difficult decisions must now be made. Among the questions to be answered are these: Shall one, two, or three demonstration plants be built? If more than one, in which order? If less than three, how can all three companies be kept in the development to provide competitive sources of supply for commercial plants? On what time scale shall demonstration plants be built? How shall the large sums needed for their construction be apportioned among the government, the three interested companies, and the many electric power companies of the United States?

While these questions are being debated in the United States by many government and commercial interests, foreign projects have been moving faster. In Russia, England, and France, government agencies have had full responsibility for breeder projects and have driven ahead with construction of demonstration plants without waiting for the exhaustive testing of components now characteristic of the U.S. program and without trying to establish several competing sources of supply. Unless these foreign projects run into major difficulties, liquid-metal fast breeder reactors will become commercially available abroad many years earlier than in the United States. There is a definite possibility that in the 1980's U.S. power companies will be buying breeder reactors from France, England, or Germany instead of from Schenectady, Pittsburgh, or Los Angeles. Many U.S. reactor engineers, including myself, believe that the technology of the liquid-metal fast breeder reactor is sufficiently advanced to justify starting construction of at least one demonstration plant here and now before we lose the momentum of our present fast reactor program.

We cannot wait to start construction of such a demonstration plant until the eventual shortage of uranium is upon us. Bringing the first demonstration plant into operation will take at least seven years, and another seven will be needed to build the first full-scale commercial plants. Construction of the first demonstration plants for light-water reactors started 15 years ago, and these reactors are only today reaching full commercial maturity. The development period for liquid metal breeders is apt to be even longer.

Congress, the A.E.C., and the Office of Management and Budget should agree at once on a national program and a timely schedule for building these demonstration plants; then these governmental groups, the interested manufacturers, and the power companies should promptly agree on an equable plan for funding their construction.

Conclusions

These are the points I consider most important in this brief summary of power from nuclear fission:

Properly designed and operated light-water reactors have been proved to be economic, reliable, relatively unobtrusive, safe, and nonpolluting. With these reactors we

have a new energy source that can serve as our principal means for generating electricity for the remainder of this century. They are the best solution we have to the current energy crisis. Light-water reactors are economically competitive with fossil fuel for generating electricity. Their use for this purpose will conserve fossil fuel for transport, home heating, chemical synthesis, and other more versatile applications for which uranium cannot be used.

To proceed apace with light-water reactor development, we will all need to maintain a sensible attitude toward the low levels of radioactivity emitted by these power plants. It is proper and necessary that these levels be kept as low as practicable; but we should bear in mind that we are surrounded on all sides by natural radiation and should therefore not require extreme measures, incurring excessive costs, in order to limit radiation exposure from nuclear power plants to an unnecessarily small fraction of natural levels.

High-level radioactive wastes from nuclear reactors present a very different problem. There should be prompt implementation and at the same time thorough testing of the proposed long-term storage of high-level radioactive wastes in bedded salt formations. Until this or an equivalent procedure has been proved by actual operation to be completely reliable, critics of nuclear power will have a valid cause for concern.

Because today's slow-neutron, nonbreeding reactors provide only a short-term solution to our electric energy needs, we must move ahead aggressively with the development of breeder reactors; one or more demonstration plants of the liquid-metal fast breeder type should be built as soon as possible. All present indications are that the fast breeder reactor is our best hope for providing electric energy in practically unlimited amounts for thousands of years. We cannot afford to allow other nations to pass the United States as the leader in this vital development.

Suggested Readings

"Civilian Nuclear Power: Current Status and Future Technical and Economic Potential of Light-Water Reactors," U.S. Atomic Energy Commission Report WASH-1082, March, 1968.

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by Richard G. Bowen
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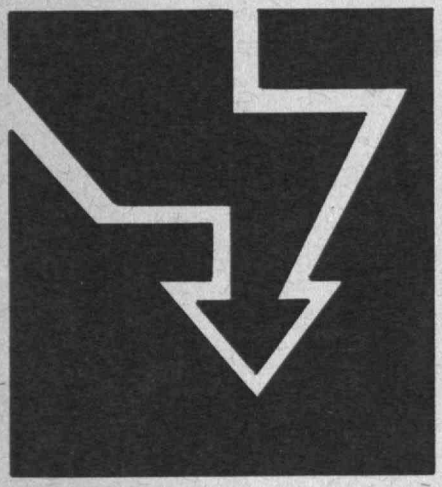
Oregon Department of
Geology and Mineral Industries

Geothermal—Earth's Primordial Energy



Heat is conducted outward from the interior of the earth at an average rate of about 150 Btu./sq.mi. per second—that is, about 150 kw./sq.mi. (electrical equivalent). The heat flow to the total surface of the earth for a period of one year is about equal to the heat value of 170 billion barrels of petroleum.

Unfortunately, we cannot directly exploit this tremendous heat supply. We can use only the local "hot spots" —subterranean reservoirs where the heat has accumulated and is stored in the form of steam and hot water. Such reservoirs are the source of geothermal energy. To understand their origin and distribution, we must know a little geology.

The Geological Setting

The earth's crust is four to five miles thick beneath the oceans and 20 to 35 miles thick under the continents. Below this crust lies the mantle, which extends down 1,800 miles to the boundary of the earth's core. The upper part of the mantle, which is quite variable in composition and temperature, is believed to be the source of magma, that mixture of molten rock and gases that penetrates the crust and erupts at the surface in volcanoes. Magma can also remain within the crust, where it forms sources of heat.

Along the continental margins encircling the Pacific Ocean there is a belt of crustal deformation, evidenced by the squeezing and breaking of the rock strata. Volcanic eruptions and earthquakes are characteristic of this belt. A similar belt extends through southern Europe and across the middle of Asia, connecting with the Indonesian Island chain.

Within the deep ocean basins another type of belt encircles the earth. This is a system of ridges, along which the oceanic crust is apparently spreading apart and magma from the mantle is erupting. Much heat flows up through the crest of the ridges. Where a segment of the ridge passes under the continental crust, rifting of the land surface is evident, as in East Africa, the Red Sea, the Gulf of California, and Iceland.

These movements of the earth's crust are apparently driven by slow convective motions within the upper mantle, and this convection is driven by the earth's internal heat. The heat is considered to originate mostly from radioactive decay.

Within the continental belts of relatively recent volcanism and deformation, heat flow is higher than the terrestrial average. This is to be expected: in these regions, magma is intruding and penetrating to shallower levels of the crust. The high-temperature geothermal areas found so far are confined to these belts of higher heat flow.

Geothermal reservoirs consist of permeable and porous rock in which, by circulation of steam or hot water, a convection system can develop. The porosity and permeability need not be inherent in the type of rock itself, but can result from fracturing due to deformation. Ground water, which can percolate down to depths of several miles, is heated directly or indirectly by the underlying magmas, expands, and ascends towards the surface.

For this water to form a heat-reservoir, a cap or cover of some sort is required; otherwise the heat simply dissipates. Often this capping is provided by a layer of impervious rock overlying the permeable reservoir rock, as at Wairakei, New Zealand, and Larderello, Italy. In other instances the ascending hot water deposits mineral material as it cools

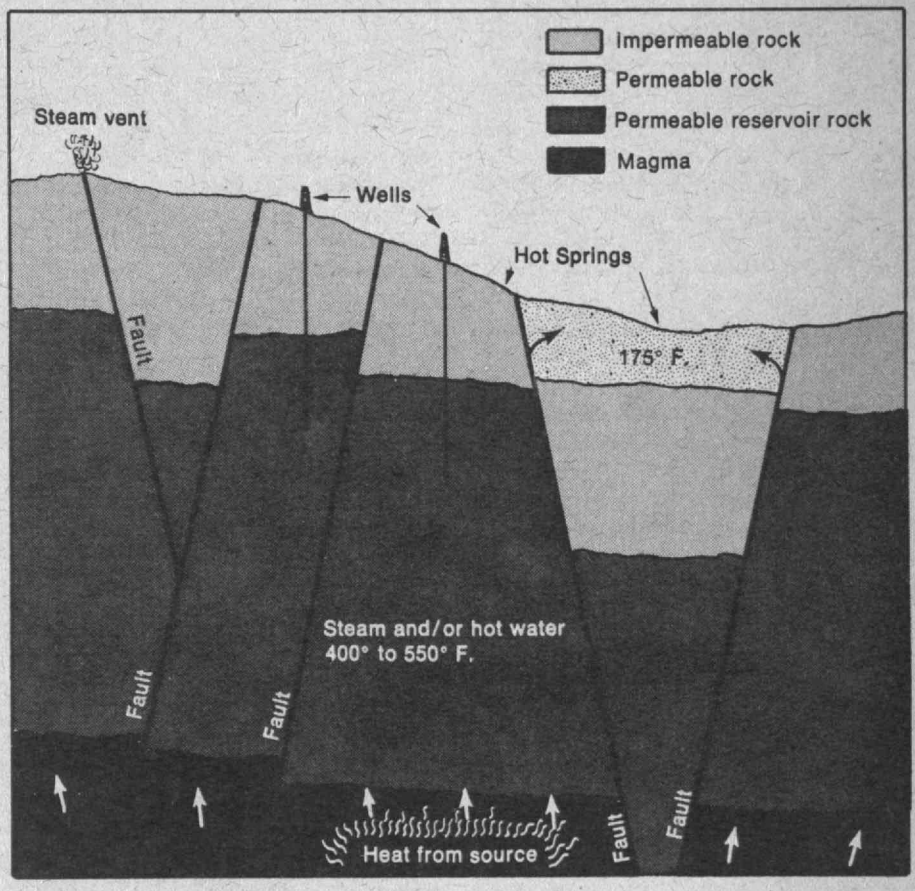
Only a fraction of the earth's interior heat may ever be available to man. But geothermal sources are now grossly underdeveloped; they hold the potential for a significant increase in U.S. energy resources.

in pores and fractures of the rock through which it passes, thereby gradually sealing off its exit to the surface.

A geothermal circulation system can thus transfer heat from deep to shallower levels. With time, enormous amounts of heat in the form of steam and very hot water can become stored in a reservoir. Temperatures in the geothermal reservoirs vary from around 400° to 700° F. Such reservoirs provide sufficient concentrated thermal energy to be suitable for the production of electric power; they are most satisfactory for this purpose when the heat can be tapped within depths of 2,000 to 8,000 feet.

There is another type of reservoir, containing large amounts of water at temperatures ranging from 150° to 200° F. at relatively shallow depths. Such sources are located in large sedimentary basins (such as the Hungarian Basin) that have undergone geologic deformation, such as folding and faulting, but apparently without magmatic intrusions or volcanism. Because of their large areas, these basins represent tremendous stores of heat. They are found in the southern part of Russia, in Australia, and in several other countries. During the course of oil exploration along the U.S. Gulf Coast large reservoirs, sometimes covering hundreds of square miles, have been found to contain waters with temperatures as high as 365°F. at pressures greater than 10,000 lb./sq.in. While not satisfactory for electric power production by current technology, this lower quality heat can be, and is, utilized in other ways, mainly for space heating.

Regions of high heat flow usually display hot springs, geysers, and fumaroles or steam vents, these features representing leakage from a



Schematic cross-section of a geothermal reservoir capped by impermeable rock within a faulted structure.

deeper geothermal reservoir. Man's ability to drill deeply into the earth, acquired over the last few decades, has enabled him to probe beneath these surface manifestations with productive results—for example, at Larderello in Italy, Wairakei in New Zealand, and at The Geysers of California.

Exploration

Surface heat displays are somewhat analogous to the oil seeps that occur in regions underlain by petroleum pools or reservoirs. In the early days of petroleum exploration, many oil pools were found by drilling on or about such seeps. But not all seeps proved productive. Later, through geological and geophysical methods, it was discovered that the pools often lay at distances far removed from the seeps, and that the oil had migrated to the surface by devious paths. This can be true also of hot springs in relation to their underlying geothermal reservoirs.

Thus exploration for geothermal reservoirs requires careful study of the geology and structure of the chosen area. Favorable areas seem to be those in which blocks of the earth's crust have subsided or been uplifted by earth movement and volcanic processes. Volcanic features known as calderas, where tremendous volumes of material have erupted explosively followed by the later collapse of the strata overlying the magma chamber, are receiving increased interest for geothermal exploration.

There are many methods for seeking out geothermal reservoirs existing at depth, although none offers conclusive predictions. Measurement of the gravity field over an area, for instance, can help define structure and indicate the presence of intruding magma. A large negative gravity anomaly near The Geysers steam field is interpreted as showing the presence of a shallow magmatic intrusion, although this was not known at the time of the early development of this field. Electrical measurements may point to geothermal reservoirs, by virtue of the low conductivity caused by high temperature and saline water content. This method has been fruitful in exploring the geothermal areas of New Zealand, and recently it helped to discover some new geothermal areas in the Imperial Valley, California. Magnetic surveys also are useful.

Active seismic methods, which use explosions to initiate seismic waves that can penetrate through the underlying rock, are used to reveal faults, rock structure, and rock properties. Passive seismic methods listen to locally generated microearthquakes and thus disclose earth-movement activity, which may be associated with geothermal systems. A variation of this method, called geothermal noise detection, records certain sound frequencies characteristic of geothermal fluid circulation.

Geochemical methods have been applied vigorously by the New Zealanders in the exploration and development of their geothermal resources. By analyzing the chemical content of spring waters, something can be learned about the temperature and type of geothermal fluids existing below. Similar research has been done in Iceland and in the United States, although the U.S. work has not, until recently, been particularly directed to the finding of geothermal resources.

One finding from these studies is that most of the water contained in geothermal systems came originally from the surface of the earth as rain or snow; very little, if any, has been contributed by the magmas. So we can picture the geothermal water as a true natural heat-transfer circuit.

Resources and Developments

Since 1904, when electricity was first produced from a small plant installed at Larderello, Italy, the worldwide geothermal power capacity—generators being driven directly by pressure developed from geothermal heat—has grown to some 700,000 kw., and should expand greatly over the next couple of decades. Italy, the pioneer in geothermal energy, has an installed capacity of around 400,000 kw., most of it in the Larderello area. These steam fields are now being used essentially to full capacity, and exploration is proceeding with the aim of increasing output at other geothermal locations in Italy.

The Larderello reservoir, covered by an impervious layer of rock, produces steam varying between dry and slightly superheated, at pressures around 50 to 75 lbs./sq. in. as delivered to the turbines. An unusual feature is the absence of "young" volcanism in or near the area; but the rocks have been deformed in recent geologic time. The source of heat is thought to be intrusive magma at depth.

Second in geothermal pioneering has been New Zealand—second, that is, in timing, rather than in effort applied. The great surface thermal displays of North Island have long been known the world over, and in the early 1950's plans were made to develop electric power from the underlying reservoirs. The Wairakei field constitutes the main development to date, with a capacity of 192,000 kw. A newly discovered field, Broadlands, is planned for a capacity of 120,000 kw.

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A large subsided crustal block extends through the center of North Island, New Zealand. Intense volcanism, faulting, and fracturing have occurred within this feature in late geologic time and continue to the present. The geothermal reservoirs are contained in a highly permeable rock formation overlain by an impermeable capping layer. The geothermal fluid is a very hot water (around 500° to 550° F.). Wells produce a steam-water mixture from which the steam is separated and sent to the power plant.

Presently third in geothermal power capacity is the United States, with an installed capacity of 82,000 kw. and 330,000 kw. under construction—all of this at one steam field, The Geysers. The ultimate capacity of The Geysers area has been variously estimated at from 2 to 5 million kw.; it is the largest known dry-steam field in the world. The steam is drawn, via wells up to 9,000 feet deep, from a reservoir having a pressure of about 500 lbs./sq. in. It is fed to the turbines at a temperature of 340° to 355° F. and a pressure of 80 to 100 lbs./sq.in., slightly superheated.

The Geysers reservoir is contained in an assemblage of impermeable rocks which have been heavily faulted and fractured. The intricate network of fractures gives the reservoir high permeability, resulting in large steam flows to the wells. The reservoir's "cap" is apparently the result of sealing by mineral deposits.

Much needs to be learned about this outstanding geothermal source, since its characteristics most nearly approach the ideal, in the hope that many more of this type can be found in the United States and throughout the world. Dry steam has recently been reported from a well drilled in the Valles Caldera, Sandoval Co., New Mexico, and this may represent the beginning of a second United States dry steam field. A very hot brine, with temperatures running up to 650° F., has been produced at the Salton Sea area in the Imperial Valley of southern California, and recent studies indicate the existence of other reservoirs in the Imperial Valley. The estimated total heat content is enormous, but technical problems in handling the hot corrosive solution have thus far stymied its use.

Mexico is presently installing a 75,000-kw. plant at Cerro Prieto in the southern extension of the Imperial Valley. Here the mineral concentration in the very hot waters is much less than in the Salton Sea field, and steam is being produced by flashing (rapid evaporation) and separation, as practiced in New Zealand.

Japan is generating 20,000 kw. from a dry-steam field located in a caldera and another 12,000 kw. from a hot-water reservoir. Since Japan is so short of indigenous energy resources, these plants will be enlarged and the rate of exploration will continue to grow. The U.S.S.R. has a small plant operating on the Kamchatcka Peninsula, a region of recent volcanism, and further explorations are proceeding. Many other countries in Central America, western South America, and East Africa—including also Turkey and Taiwan—are now actively seeking geothermal resources.

Lower-temperature geothermal reservoirs, containing waters at temperatures from 150° to 250° F., are not efficient for power production by conventional methods. But their energy may be used for a variety of heating purposes with considerable saving in fuel costs. Iceland is the outstanding example here: the city of Rekjavik, population 60,000, is heated by geothermal hot water almost exclusively, as are many smaller outlying communities. Geothermal water also provides heat for greenhouses, drying, domestic hot water, swimming pools, and many other purposes.

Hungary and the U.S.S.R., with immense reservoirs of this type, are making similar uses of the heat, and more modest applications are being made in other countries, including the United States. At least 400 residences, several schools, and a number of businesses are using natural hot water at Klamath Falls, Ore. A large commercial tomato greenhouse is heated this way at Lakeview, Ore., and at least 200 residences in Boise, Idaho, receive this type of heat. Numerous other small installations have been made locally throughout the western states where hot waters from springs and wells are easy to reach.

Economics

In Italy and the United States, where dry steam has been utilized for electric power production long enough to develop comprehensive cost figures, both capital and operating expenses are lower than for other types of thermal plants. The construction cost of a geothermal plant is two-thirds to three-fourths of the cost of a comparable fossil fuel plant and less than half that of a nuclear plant. This saving is related quite simply to the absence of a man-made boiler, and of the related complications of fuel handling and combustion. A geothermal plant is relatively simple to operate; The Geysers plant normally operates unattended (but protected by automatic equipment) for 16 hours out of 24, with maintenance personnel on hand only during the day.

The accompanying table, compar-

The price of power generated from geothermal sources is competitive with that by other methods. The plant investment figures given at the right are based (except for hydropower) on the average for new tax-paying, privately financed plants ordered in the U.S. in 1970. Oil-fired plants have essentially the same energy cost (3 mills/kwh.) as coal-fired; the energy cost shown here for geothermal (2.66 mills/kwh.) is that paid by Pacific Gas and Electric Co. at The Geysers. The variable load factors assumed in the total cost computation are 55 per cent for coal and oil, 65 per cent for hydropower, and 90 per cent for nuclear and geothermal.

	Electric Power Costs:			
	Geothermal	Nuclear	Hydropower	Coal
Plant investment, $/kw.	$110.00	$225.00	$250.00	$150.00
Fixed charges, 14%/year/kw.	15.40	31.50	35.00	21.00
Fixed charges, mills/kwh.	1.95	4.00	6.10	4.36
Operating costs, mills/kwh.	0.25	0.50	0.10	0.25
Energy costs, mills/kwh.	2.66	2.00	——	3.00
Total costs:				
Variable load factor, mills/kwh.	4.86	6.50	6.20	7.61
90% load factor, mills/kwh.	4.86	6.50	4.55	5.92

ing the cost of geothermal, nuclear, hydro, and coal power, reveals the advantage of geothermal as a source of electrical energy. Only hydropower plants can produce power at lower cost; however, most low-cost hydro sites are already utilized, and because of the fluctuating nature of rivers, hydropower plants must run at low load factors.

The unknown factor in any geothermal power program is the effort of finding the natural steam, which must of course be used locally (unlike coal, oil, gas or uranium) and must therefore be found before a plant can be planned. This requires high expenditures for exploration, but the reward for success can be substantial. If exploration costs amount to $10,000,000 before usable steam is struck, for example, then exploration costs per unit of power (assuming in every case that exploration costs are amortized at 14 per cent per year) for a 1,000,000-kw. field would be only 0.175 mills/kwh.

Given a dry steam field similar to The Geysers, a utility that chose to develop its own steam source rather than purchase steam from outside suppliers (as Pacific Gas and Electric Co. has done in that particular case) could reduce power costs even more. The costs of developing steam, as reported by D. A. McMillan, Jr., president of Thermal Power Company (one of the developers of The Geysers field), average $150,000 per well, of which the average capacity is 8,000 kw. In addition, steam transmission lines cost $8 to $10 per kw. By extrapolation, the total power costs can be reduced to 3.35 mills per kilowatt hour, as given in the accompanying exhibit.

Most utilities are limited by their charters from entering into such ventures as steam exploration, and few have that kind of expertise or philosophy. The oil companies, on the other hand, already have a broad knowledge of geologic environments, drilling technology, and reservoir engineering. It is they, along with independent "wildcatters," who will probably lead the search for new sources of geothermal energy.

Economies of scale are not as important in geothermal power generation as in other types of plants. This can be an advantage. In order to achieve low power costs in a nuclear, hydro, or fossil-fuel plant it is necessary to construct plants of hundreds or even thousands of megawatts. So in many cases utilities must either overbuild and wait for demand to catch up to plant capacity, or sell power at wholesale to other utilities. Unit costs of geothermal plants change less than other thermal plants as the size increases, so a utility can economically start small and add generating units either as more steam is found or as the load increases.

The question naturally arises: If geothermal power is so good why hasn't it been used more? There are several answers, of which the most important is that geothermal resources are limited in both amount and location. In the past, natural steam had to be used where it was found, whereas power had to be generated near the "load centers," where it was needed, and the two did not coincide. Abundant supplies of fossil fuels were available and could be conveniently transported. Only since the middle 1960's have high-voltage transmission techniques made it reasonable to separate plants from their principal load centers. And it was during this period, when the fossil-fuel plants were starting to move from load centers toward fuel resource areas, that nuclear plants were presented as a promising long-term alternative for large-scale power generation. Unlimited amounts of power were foreseen at a cost of less than 4 mills/kwh. and capital costs of $100 per kilowatt, a price less than most fossil fuel plants at that time. Nuclear plants have not come close to achieving these promises. Nuclear commissioning delays, and in some cases cancellations, along with rising prices of fossil fuels and growing objections to putting central-station power plants in urban areas (plus the obvious success of The Geysers field and the improvements in high-voltage transmission) have greatly increased the attractiveness of geothermal power within the last few years.

Environmental Effects

Natural steam power plants have very little impact on the environment. Natural steam from the earth is remarkably low in atmospheric pollutants. There is no fly-ash, no nitrogen or sulfur oxides, and no radiation hazard. The only significant environmental hazard in geothermal power production is the effect on water quality of improper control of excess steam condensate. Natural steam is almost entirely pure water, but small amounts of other gases are liberated and produced along with the steam. The noncondensable gas content varies from an average of 0.5 per cent at The Geysers field to an average of 4 per cent at Larderello. The noncondensable fraction usually runs about 90 per cent carbon dioxide, the rest being mainly methane, hydrogen sulfide, and ammonia. Although these gases are vented from the condenser into the atmosphere, they are not considered an environmental hazard because of their low concentrations

and because of the remote locations of the plants.

Hydrogen sulfide presents a potential problem with the enlargement of geothermal installations, but it can be extracted chemically from the noncondensable gas and converted to elemental sulfur. The production of sulfur from "sour" gas is common practice in many natural gas fields. As the size of geothermal plants increases, sulfur will undoubtedly be extracted for economic ends as well as in order to alleviate environmental effects.

The steam condensate, too, carries trace amounts of detrimental substances, mainly boron and ammonia, which if released into surface drainages would affect downstream water quality. At The Geysers field the surplus condensate, which totals about 20 per cent of the total fluid produced, is injected back into the producing reservoir. An added benefit, aside from preserving surface water quality in the area, is that the life of the reservoir is probably extended by returning this fluid.

Thermal pollution may be produced when steam plants return heated condenser-cooling water to the surface drainage. But because geothermal plants return this heated water to the subsurface reservoir, there is no thermal pollution.

The problem of availability of condenser cooling water is a serious barrier to the expansion of all types of thermal plants except geothermal. This is true because geothermal plants using dry steam are able to condense the steam and then use it for cooling, so no supplemental source of cooling water is needed once the steam is found. The significant point here is that geothermal plants, unlike other types of thermal plants, do not compete with other users of fresh water.

Steam winning:	
Wells necessary to produce steam for 110,000-kw. plant (16 wells at $150,000)	$2,400,000
Steam transmission lines at $10/kw.	1,100,000
Total	3,500,000
Overhead charges:	
Annual fixed charges at 14%	$ 490,000
Royalty payment to landowners	175,600
Total annual	665,600
Heat cost:	
Steam winning cost in mills/kwh.	0.80
Exploration, mills/kwh.	0.33
Disposal charge, mills/kwh.	0.02
Total energy cost, mills/kwh.	1.15
Conversion cost:	
Fixed charges, mills/kwh.	1.95
Operating cost, mills/kwh.	0.25
Total power cost, mills/kwh.	3.35

This exhibit shows how the various costs associated with developing, building, and operating a geothermal plant contribute to the total cost of power from it, in the case of a utility producing its own steam from its own wells. Exploration charges are based on spending $2 million to find a field capable of supporting a 110,000-kw. installation.

Prospecting in Earnest

The pace of geothermal exploration and development has been slow in the United States for the last ten years because the federal lands, where most of the geothermal resources are believed to lie, were closed to development. The recent enactment of a federal leasing law opens these lands, which amount to 50 per cent of the area of the 11 western states and probably include 75 per cent of the potential geothermal sites.

During this ten-year delay the economic attractiveness of geothermal power has brightened considerably, for the reasons already mentioned. The success of The Geysers field provides a model. Though some geologists have felt that the known dry-steam fields are unique, worldwide exploration for other mineral resources has rarely shown that a particular resource is restricted to only one or two localities. Geothermal energy should be no exception; the recent discovery of dry steam in the Valles Caldera of New Mexico illustrates this point.

The development of natural steam was begun by small companies set up for that specific purpose, but lately the international oil companies have entered the field, either as partners or as an adjunct to their other operations. This infusion of practical knowledge, along with capital to finance the work, is starting to change exploration practices in the natural-steam industry. In the past, exploration consisted mainly of finding a hot spring and drilling it; now geological, geophysical, and geochemical studies are made prior to drilling, increasing the chances of success. Drilling and well-completion technology has improved; bigger drilling rigs can sink larger bores to much greater depths, increasing the steam flow and individual well productivity.

Hot Water and Ingenuity

The outstanding success of the dry-steam fields was recognized at the United Nations Symposium on the Development and Utilization of Geothermal Resources in Pisa, Italy, in September, 1970. It was recognized at this symposium that most geothermal energy now comes from dry-steam fields and that exploration for additional such fields should be intensified. But it was also recognized that most geothermal energy now known is in the form of hot-water fields and that more effort should be devoted to extracting the maximum energy from this hot water. Many schemes were discussed for using lower-temperature waters for purposes other than space heating: for example, absorption refrigeration for food processing and air conditioning, and electric power production by the use of intermediate low-boiling-point fluids. There are some real engineering challenges here.

From New Zealand came reports of a joint heating and cooling system being used in a resort hotel. An American group, Magma Energy Co., described a scheme for producing electricity from a turbine driven by isobutane heated by a natural-hot-water heat exchanger. These methods are less efficient than the direct use of natural steam, where it is available, but they compete favorably with fossil fuel burned in smaller plants or in regions of high fuel cost.

A patent has been granted for a multiple-use scheme to produce electricity by a two-stage process: the high-pressure natural hot water is brought to the surface through a hydraulic turbine attached to an electric generator. Upon expansion through this turbine the steam is flash-evaporated into a normal low-pressure turbine, while the hot water is used for industrial process heat. In addition, where this over-pressured water contains dissolved natural gas (as in the Gulf Coast region) this fuel can be separated for commercial use.

It appears that in the past the quantity of usable geothermal energy has been considerably underestimated. Nearly all forecasts were based on extracting a certain amount of energy from known thermal areas. The possibilities of finding concealed deposits, or of increasing the energy flow from known areas by deep drilling, were not considered—which was rather like estimating oil reserves from the flow of known seeps.

Estimates of U.S. geothermal capacity range between 30 and 100 million kw.—a significant amount of power when it is considered that the present installed generating capacity in the United States is 300 million kw. These estimates do not take into account the developmental potential of the thermal waters in the sedimentary basins outside of the belts of high heat flow.

If the development of The Geysers field is an indication of what might be expected from other discoveries, the estimates have erred on the low side. At The Geysers, the original area where shallow steam production was discovered was about 200 acres. Based on the well spacing used at that time (100 to 150 ft.), reservoir studies indicated that the area could produce sufficient steam for about 200,000 kw. Since then new discoveries have extended the bounds of the field to encompass an area about seven miles long and two miles wide. As the wells were drilled deeper and the bore size enlarged, production increased from an average of 75,000 to 200,000 pounds of steam per hour. As we have mentioned, estimates of the ultimate capacity of the field now range from 2 to 5 million kw., and new discoveries now suggest that the limits of the field have still not been reached.

A group of University of California scientists studying the geothermal power potential of the Imperial Valley geothermal field estimated that it has a potential of 20 million kw. If these predictions for two areas in California prove well founded—and now that the western lands are more fully open to exploration—the remainder of the West may account for at least another 75 million kw.—which, if realized today, would represent a 25 per cent addition to U.S. energy capacity.

Suggested Readings

"Power from the Earth's Heat," Lawrence Lessing, *Fortune,* June, 1969.

Geothermal Power, An Economic Evaluation, Alvin Kaufman, U.S. Bureau of Mines Information Circular 8230, 1964.

Exploration and Development of Geothermal Power in California, James McNitt, California Division of Mines and Geology Special Report 75, 1963.

"Geothermal Growing as Power Source," *Electrical World,* June, 1970.

N.A.S.A.'s progress toward a reusable earth-to-orbit vehicle has now reached the point where major funding must be committed. But the political and economic environment for this decision is very different from that in which Apollo became the nation's great destiny.

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Shall We Build the Space Shuttle?

During the coming months, the President and the Congress may be asked by the National Aeronautics and Space Administration to approve full-scale development of a new system which top space officials have described as the "keystone to the total plan for the U.S. space program" and "the top priority space program of the 1970's." This system, the space shuttle—in essence, a reusable system for transporting payloads to and from earth orbit—will cost over half as much as Project Apollo by the time the first shuttle fleet becomes operational ten or so years from now.

Whether N.A.S.A. will be allowed to proceed with this ambitious undertaking is not clear; the agency's request faces a political and economic environment very different from that which prevailed in 1961 when President John F. Kennedy asked that a manned lunar landing before 1970 be set as a national goal.

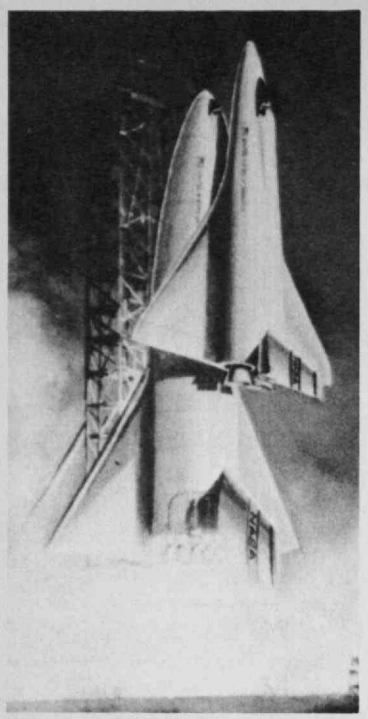
The motivations underlying the decision to begin Project Apollo were preeminently political. Top priority was given to the symbolic U.S.-Soviet competition in space spectaculars. Considerations of cost-effectiveness or of tangible benefits resulting from N.A.S.A. programs had decidedly lower impact on the shape of N.A.S.A.'s programs. The nation's economy was sluggish, and President Kennedy and his economic advisors believed that increased public spending was required to initiate some economic dynamism.

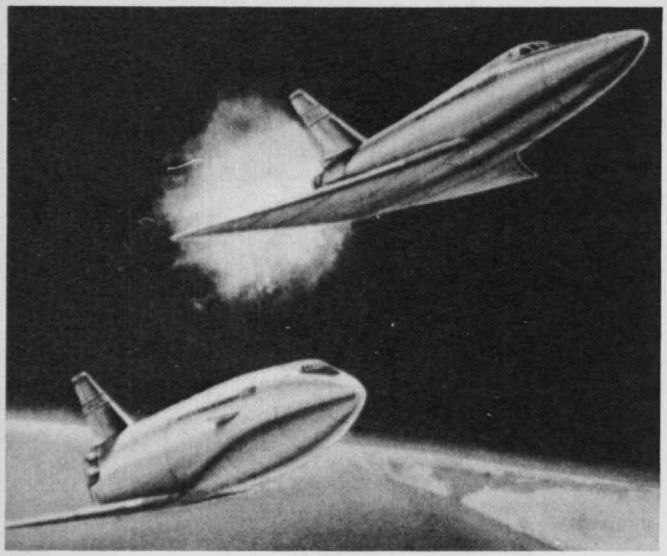
Now, there is far less fear of a Soviet threat to spur competition and innovation. There is a general questioning of the value of massive federal investments in large scale technological enterprises. N.A.S.A. is being asked to demonstrate, in advance, that its plans for the next decades have some relevance to a revised set of national goals and priorities, which seem to be largely economic and utilitarian in nature. The nation's economy is inflated and unemployment is high; the President in August imposed strict economic controls; money for new federal programs next year will be extremely scarce. Support of the space program has become a political issue, and next year is an election year for the President and for most members of Congress.

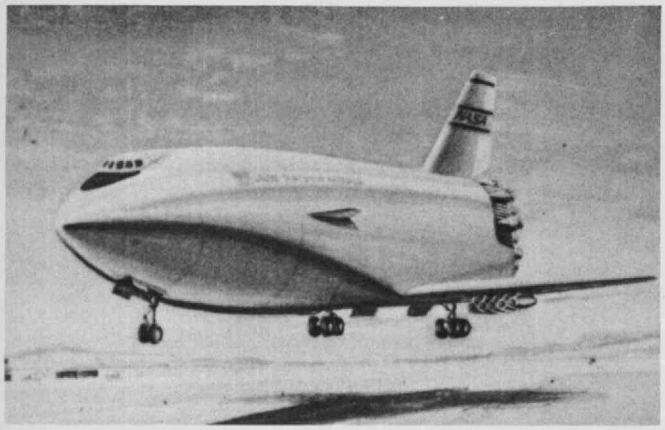
This is not an environment very congenial to the start of an expensive new space program, but N.A.S.A. believes that the contracts for the development of the shuttle must be awarded soon if the space agency and its contractors are to keep together the engineering teams that are already working on shuttle design studies. N.A.S.A. leaders justify the shuttle in terms of a variety of national needs, but it is also true that the Agency must have an extensive and technologically challenging new program to maintain large development centers at Houston and Huntsville. The shuttle is the only such program now under consideration. Further, the agency needs some semblance of a future manned space flight program in order to maintain its highly visible public image. And for the aerospace industry (now that the S.S.T. has been cancelled) the shuttle represents the only big-money, non-military, high-technology program on the horizon.

The stakes riding on the shuttle program are thus very high. Yet, ever since its inception, the program has been characterized by shifting justifications and rapidly changing performance requirements. It began as a program to support a manned space station. Now it is talked about primarily in terms of the cost savings it will provide for unmanned scientific, commercial, "applications" and military missions during the 1980's. Recently, after supporting industry studies of the concurrent development of the two sections of the shuttle (the booster and the orbiter) for over a year, N.A.S.A. asked its contractors to examine a sequential or "phased" development program, with the orbiter development preceding the booster development by three years and the first orbiters therefore destined to make their test flights from conventional one-shot boosters. That the orbiter should have a delta-wing configuration capable of extensive maneuvering in the upper reaches of the atmosphere—rather than a less steerable straight wing design—was decided only last January, in large part to obtain Air Force support of the program.

The economic analysis upon which much of N.A.S.A.'s justification for the program rests is complete, and the results are favorable, if the assumptions underlying them are accepted. The validity of this analysis may be undermined by increasing development costs and delayed benefits, especially if the phased approach to shuttle development is selected. Such a phased approach may be necessary if the peak N.A.S.A. budgets for the late 1970's are to remain below the $4 billion figure which agency planners consider politically realistic.







N.A.S.A. still has alternatives to the shuttle as its major program for the rest of this decade under study, and the Agency has until September 30 to decide what to request in next year's budget. But there has been so much attention given to the shuttle, both within and outside the Agency, that a N.A.S.A. decision to proceed with the shuttle if authorized to do so seems almost certain, barring a budget ceiling that would make this impossible. If this is so, then N.A.S.A has its work cut out if it is to present a coherent and convincing case for the shuttle to the President and his Office of Management and Budget this fall and to the Congress next spring. The issues involved are complex, and cover a wide range of interests in areas where technology, economics, and politics interact. This article will review some of those issues and hopefully thereby contribute to informed public involvement in the ultimate decision as to whether or not this country should decrease, maintain, or expand its activities in space during the rest of this century.

Shuttle Design and Operation

The requirements which N.A.S.A. has set for contractors working on the design of the shuttle aim toward the development of a reusable two-stage vehicle with these characteristics and capabilities:

☐ The orbiter will approximate the size of a Boeing 707, and the booster the size of a 747. The combined stages will weigh between four and five million pounds at launch.

☐ Each stage will be flown by a two-man crew.

☐ The orbiter will be able to carry up to 65,000 pounds of payload or 12 passengers into an equatorial orbit, or up to 40,000 pounds into polar orbit. The interior of the orbiter will be pressurized, so that passengers and crew will not have to wear space suits. Stresses during acceleration and deceleration will be low enough so that people in normal health will be able to withstand them without special training.

☐ The orbiter will be able to remain in orbit for at least seven days—more if payload weight is sacrificed for additional life-support capability. Thus the orbiter can serve as a short term space station or research base.

☐ Both the booster and the orbiter will be able to land on a conventional runway of about the length used by today's long-range jets.

☐ Each stage will be reusable for a minimum of 100 flights over a 10-year lifetime, with a maximum of two weeks required for refurbishment between flights.

☐ The shuttle and its crew will be able to perform a wide variety of tasks in orbit, including: carrying satellites to earth orbit and making sure they are properly deployed and in working order (satellites launched by the shuttle will be constructed with less stringent weight and size restrictions than is now the practise); rendezvousing with all kinds of satellites (presumably including non-U.S. ones) to repair, resupply, or inspect them or to return them to earth; rescuing astronauts or cosmonauts stranded in earth orbit;

deploying a "space tug" which can be used to carry payloads out to the 22,000-mile geosynchronous orbit, or deploying payloads with associated propulsion systems for deep space missions; and assembling modules in orbit to build a large space station, a nuclear rocket, or spaceships for journeys to the moon or the planets.

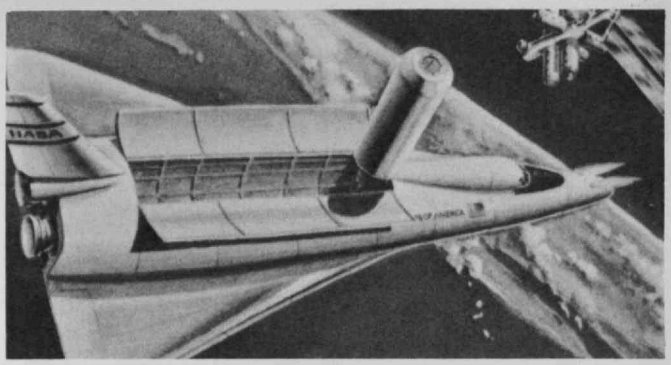
Origins of the Shuttle Program

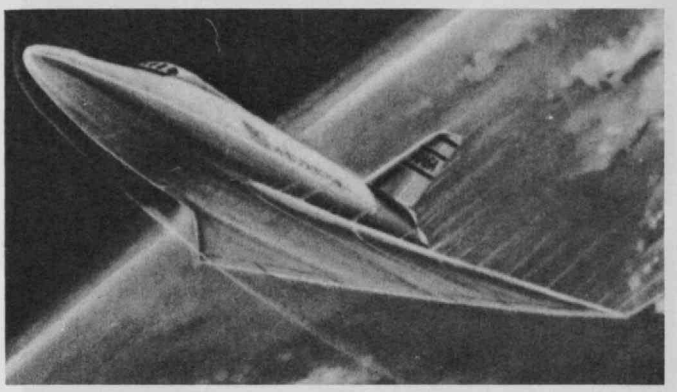
The shuttle originated almost exclusively in the context of a *manned* program, and its identification with N.A.S.A.'s desire to continue a large manned-flight program is one source of criticism of the project. Although N.A.S.A. now stresses the use of the shuttle to orbit, revisit, repair, and return unmanned satellites, many people still regard the manned-flight motivation as the primary, though now de-emphasized, reason for going ahead with the program. The Federation of American Scientists, for example, in opposing the program, claims that "the shuttle is justifiable only by a plan for substantial manned occupation of orbit."

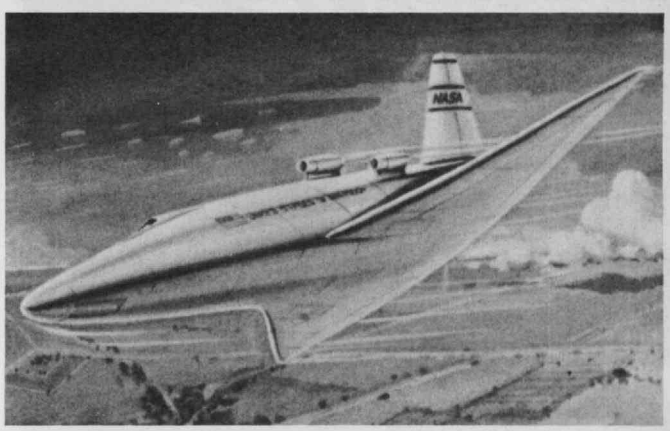
N.A.S.A.'s Deputy Administrator George Low argues that "the United States must maintain a 'presence' in space and that maintaining such a presence is inconceivable without a manned component to our space flight efforts." Low comes to "the inescapable conclusion that the United States must maintain a manned space flight program." He suggests that the appropriate question is thus "whether or not the space shuttle is the right [manned] program, as opposed to the question of whether or not there should be a manned space flight program." Although public enthusiasm for new manned flight programs is now at an ebb, it is difficult to conceive of a President of the United States deciding in effect to abandon manned space activities for the next decade or more at a time when the Soviet Union is developing increasingly more complex and longer-duration earth orbital stations.

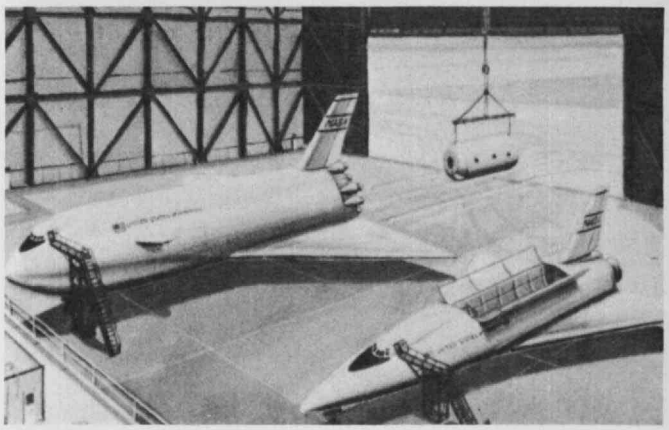
In one sense, the space shuttle is competitive with several plans for further manned space flights using modified Apollo hardware currently being pushed by some in N.A.S.A. and in Congress. If the shuttle were to be funded at the rate now anticipated in the 1975-1978 period, there would not be enough money left in N.A.S.A.'s overall budget to support such missions.

There is some irony in this, for manned-flight enthusiasts were the initiators of N.A.S.A.'s shuttle program. Although the idea of reusable spaceships and boosters is not new, the concept came under renewed scrutiny as N.A.S.A. attempted to formulate detailed plans for the agency's future beyond the Apollo program. Previously, N.A.S.A. had done little long-range planning; there had been an almost implicit assumption that the agency would continue to be dominated by a manned space flight program and that the logical next step in that program was the development of a large earth-orbiting space station capable of supporting anywhere from six to fifty men for extended periods. However, when N.A.S.A. began to examine the economic dimensions of such a station in some detail, it found that over two-thirds of the yearly cost of station operation came from the need to provide it with personnel, expendable supplies, and new experiments. It was clear that the space station program would be neither economically nor politically viable unless these recurring costs were

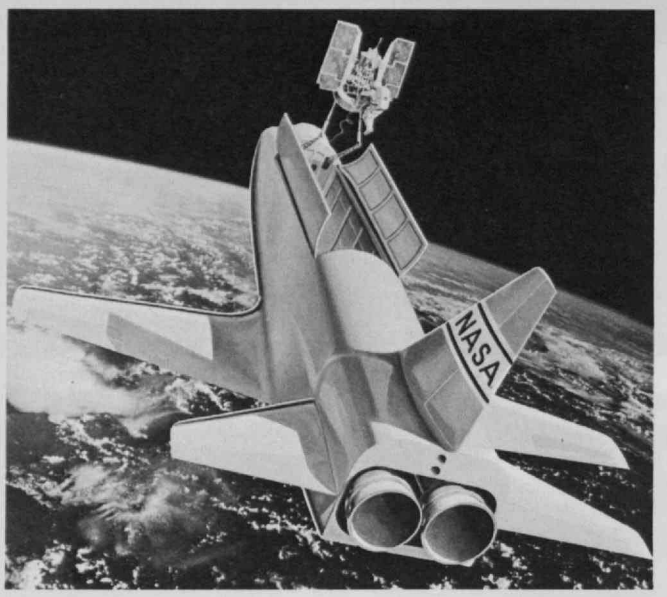


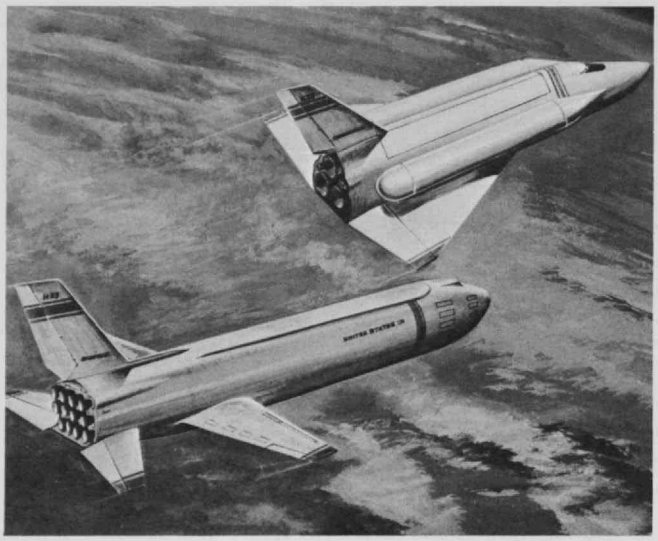






These impressions by a N.A.S.A. artist show (top to bottom, opposite and above) the phases of a shuttle mission: launch—separation of the orbiter stage from the booster stage—return flight of the booster—visit of the orbiter to a space station—return flight, landing, and reprovisioning of the orbiter.





Until recently the orbiter vehicle was envisaged as having straight wings (top)—a design which would minimize re-entry heating and would be less costly to develop. But military purposes required greater maneuverability in the atmosphere, and N.A.S.A. has therefore chosen the more costly delta-wing configuration (center). The model photographed at the bottom illustrates the so-called phased approach to shuttle development—an orbiter stage combined with a conventional, non-reusable booster (in this case that of a Saturn V). Note also, in this and the preceding picture, another recent orbiter variation, non-reusable fuel tanks.

reduced. From this realization, it was but a short jump to the conclusion that a low-cost space transportation system, along with the space station, was an essential N.A.S.A. program for the 1970's, and the shuttle program was born.

N.A.S.A.'s 1969 recommendations to a presidentially-chartered Space Task Group which was preparing plans for the nation's future space program noted that "a new and truly low-cost space transportation system is an integral part of the space station concept." The same theme was echoed in the N.A.S.A. budget request for 1970 and in the Congressional testimony supporting that request, in which there was a single budget item for the combined space shuttle/station program, viewed together. For the shuttle alone, N.A.S.A. was at this time projecting what now appears to have been an extremely low cost estimate of approximately $5 billion. Such unrealistically low estimates on the shuttle and several other programs N.A.S.A. was proposing at this time were one cause of a loss of Agency credibility among the staff of the White House and the Executive Office of the President. Over the past two years, N.A.S.A. has been laboring to restore that credibility; the elaborate benefit-cost analyses of the shuttle which N.A.S.A. is sponsoring are one way of doing this.

The emphasis on a key role for the shuttle in future manned programs was probably politically counterproductive, from N.A.S.A.'s standpoint. Funding of design studies for the shuttle and station became the focal point for the space program's opponents. In the 1970 House floor debate on the N.A.S.A. authorization, Congressman Joseph Karth (D. Minn.) introduced an amendment deleting all funding for development of the shuttle and station. Representative Karth had been, in the past, a supporter of the overall N.A.S.A. program but an opponent of its heavy emphasis on manned flight. He based his opposition to rapid development of the shuttle on a belief that N.A.S.A. was in fact proposing "a new space program based upon new hardware almost entirely in support of manned missions with a manned Mars landing as the ultimate objective." Karth's amendment failed, but only by a tie (53-53) vote.

A similar amendment, also aimed at blocking the shuttle, was introduced in the Senate that year by Walter Mondale and a group of liberal Senators including William Proxmire, Jacob Javits, and Clifford Case. In 1970, the Senate had three opportunities to vote on the Mondale amendment—once during the debate on the N.A.S.A. authorization and twice during the debate on the agency's appropriations. (The latter bill, which also contained money for the Department of Housing and Urban Development, was vetoed by President Nixon and passed in a revised version at the end of the 91st Congress last December). The three votes on the Mondale amendment were 29-56 (on May 6), 28-32 (on July 6), and 26-50 (on December 7). Senator Mondale argued, as had Representative Karth, that the shuttle/station program was "the first step" toward a manned Mars landing.

Although N.A.S.A. leaders privately claimed to have had the additional votes required to defeat the Mondale amendment if it ever appeared to have a chance of

passing, they clearly interpreted these votes and the accompanying debate as a signal that funding for future manned programs would have difficulty gaining Congressional approval. Perhaps more importantly, a continued decrease in the funds that the administration was willing to provide to N.A.S.A. forced the agency to abandon, during last year's budget cycle, the idea of simultaneously developing both the large space station and the space shuttle.

By this time, a variety of justifications for a shuttle, not related to a manned program *per se,* had become evident, and N.A.S.A. decided to give first priority to the shuttle and to defer development of a space station until the 1980's. N.A.S.A. officials now make a particular point of emphasizing that the agency has no plans for a manned Mars mission, and that the justification for the shuttle is independent of any such undertaking and indeed of a space station program.

Military Uses of the Shuttle

This shift in program rationale, while politically a success, has had wide-reaching effects on the technological and economic parameters of the program. Although the shuttle program had been described from the start as a national (rather than just N.A.S.A.) undertaking, as long as its primary justification was as the logistics vehicle for a space station N.A.S.A. did not pay too much attention to other possible uses. But with the space station deferred, N.A.S.A. found that it had to depend on other users, especially the military, to ensure that there would be enough missions to make the shuttle an economically sound investment.

Originally, the shuttle configuration most in favor had short, straight wings. This orbiter design minimized the heat of re-entry and was relatively cheaper to develop; however, a straight-wing orbiter would have been limited in its ability to maneuver sideways from its re-entry path. This "cross-range" capability was not particularly necessary for N.A.S.A. missions, because re-entry could be timed so that the returning shuttle orbiter was lined up with its landing strip. The Air Force, however, wanted a shuttle that could return to earth after one orbit and still be able to land at its original base. This implied maneuverability at the extremely high hypersonic speeds of re-entry. Such maneuverability was possible only if the orbiter had a delta-wing shape, and this was the configuration which N.A.S.A. selected early this year. The new cross-range capability (1100 miles) is gained at the expense of increased technical complexity and thus increased development costs, but Air Force support for the program had become a crucial requirement.

Military support for the program has indeed been obtained by this modification. Air Force Secretary Robert Seamans told the Senate Space Committee this spring that, if N.A.S.A. and Air Force studies show that the shuttle "is feasible, and can offer the desired performance and cost advantages," then "the Air Force will provide a strong recommendation that shuttle development be authorized." However, Air Force support for the shuttle has not been accompanied by any willingness to share the cost of the program during its development phases; the funding of the shuttle remains N.A.S.A.'s sole responsibility.

The Air Force is in a rather comfortable position with respect to the shuttle; it can lend verbal support to the program and can plan to use the shuttle for its current types of space operations and for new ones which the shuttle will make feasible, without giving the program the priority and funding it gives to its own development programs such as the B-1 strategic bomber and the F-15 air-superiority fighter. Seamans told the Senate committee that "I cannot sit here this afternoon and say that the space transportation system is an essential military requirement."

The fact that half or more of the missions now cited to justify the shuttle involve military or intelligence activities has meant some definite liabilities for the program. Although the general public has probably always viewed the N.A.S.A. program as having at least quasi-military overtones, the agency has gone to some lengths in the past to point out the separation between the civilian and military aspects of the American space program. Now N.A.S.A. must emphasize that the shuttle is being developed for military as well as civilian uses.

Most of the potential Air Force and intelligence missions are by their nature classified, and thus public discussion of the purposes of the shuttle must take place without any clear idea of what half of those purposes might be. N.A.S.A. is discussing cooperation in the shuttle development program with several European countries; the military aspects of the program could complicate these negotiations, which in any event do not seem very likely to be successful (*see "European Space in Pieces", by Peter Stubbs in* Technology Review *for February, 1971, p. 14*). For example, the Air Force would prefer to have a separate shuttle launch site for its classified missions, in part to avoid the security complications that would result if foreign and U.S. personnel were working together at a single shuttle base.

Shuttle Contract Competition

N.A.S.A. has already selected the contractor to develop a rocket engine, which will be used in both the booster and orbit stages of the shuttle. The agency announced in July its intention to award a $500 million contract for 36 engines to the Rocketdyne Division of North American Rockwell Corp., which developed the engines for the Saturn V booster used for Apollo missions. Close to 100 engines will eventually be required if the shuttle is approved and thus the value of this contract may approach $1 billion. Pratt-Whitney, another competitor for the shuttle engine award, is currently contesting N.A.S.A.'s selection of Rocketdyne.

However, the bulk of the money in the shuttle program, perhaps as much as $10 billion, will go to the contractors for the orbiter and booster. It is the authorization to award these contracts which N.A.S.A. will request this winter. Last year, N.A.S.A. awarded two contracts for detailed design definition studies of a two-stage, fully-reusable shuttle to teams composed of McDonnell-Douglas and Martin-Marietta and of North American Rockwell and General Dynamics. Usually, the hardware contractors for a N.A.S.A. program are selected from those who conduct these detailed design studies, and in anticipation these

aerospace giants have invested far more of their own funds in the shuttle studies than they have received from the N.A.S.A. study contracts. Initially, the contractors studied both the straight-wing and delta-wing versions of the shuttle, but since the start of this year they have examined only the delta-wing approach. These studies proceeded until June under the assumption that the booster and orbiter would be developed concurrently.

A combination of recent events have served to confuse the picture regarding the ultimate shuttle configuration, contractors, and development schedule. One firm which wanted, but did not receive, a detailed design study contract was Grumman Aerospace Corp. N.A.S.A. did award a smaller contract to a team composed of Grumman and Boeing to study a range of alternatives to the two-stage fully reusable shuttle. Among the concepts examined during this study was an orbiter that would be reusable except for some of its fuel tanks (which would be jettisoned after the vehicle reached orbit).

Grumman was also asked to study the already-mentioned phased approach to the shuttle program, in which the orbiter would be developed first and tested atop an expendable booster (existing or new) such as the first stage of the Saturn V or a modified Titan III and the reusable booster would be developed somewhat later.

In June, somewhat to the surprise of North American, General Dynamics, and McDonnell-Douglas, N.A.S.A. announced its intention to examine more closely both an orbiter configuration with expendable fuel tanks and a phased approach to shuttle development. The decision to examine the phased approach derives primarily from N.A.S.A.'s estimates that the budget required for concurrent development of orbiter and booster might be as much as $2 billion during the peak funding years in the mid-1970's. Such a large amount devoted to a single program meant that, given the budget N.A.S.A. could expect for these years, there would be little money left for its other major programs. By adopting a phased approach, the costs of the program could be spread out over several more years, thus lowering the peaks.

On July 1, N.A.S.A. extended the McDonnell-Douglas/Martin-Marietta and North American Rockwell/General Dynamics study contracts so that these contractors could examine the advantages and disadvantages of the phased approach. In addition, N.A.S.A. awarded an equally large contract to the Grumman/Boeing team for the same purpose. It is hard to escape the conclusion that this team, though late-comers to the detailed design portion of the competition, has several advantages in the contest for the ultimate development contracts, especially if a phased approach is adopted. N.A.S.A., as mentioned above, has directed the other teams to examine an orbiter design resembling that already studied by Grumman; Boeing is the developer of the Saturn 1C stage, which is one of the candidates for the expendable booster to be used during tests of the shuttle orbiter. N.A.S.A. already has a significant investment in existing test and checkout facilities adapted to this particular rocket, which has been used in the Apollo program.

N.A.S.A. officials insist that an examination of the phased approach to shuttle development is not a commitment to pursue it. The disadvantages of a phased approach include the extra cost of buying, modifying, and launching about a dozen large and expensive expendable boosters in the years between the appearance of the orbiter and of the reusable booster, and the deferred benefits of not having a fully reusable shuttle as early as possible. These disadvantages may outweigh the apparent savings in annual budgets. N.A.S.A. may therefore decide to return to a concurrent development program, say agency officials. Others close to the issue, however, see the study of the phased approach as tantamount to its adoption, in view of the strong economic and political pressure to keep N.A.S.A.'s yearly budgets down. In fact, some suggest that the *only* approach to developing a shuttle that has any chance of being approved by the President this year is one even more stretched out and constrained by budgetary considerations than that now under study.

Final results from the four contractor studies (the fourth being Lockheed, also examining the phased approach but at half the funding level of the other three teams) are due November 1. Based on these detailed studies, and assuming Presidential approval, N.A.S.A. hopes to request proposals for the shuttle development early in 1972 and to select the orbiter and booster contractors sometime toward the middle of that year. There may well be some shifts in the contractor teams as they bid on the ultimate development contracts, or N.A.S.A. may issue separate contracts for each portion of the reusable vehicle and for the expendable booster.

Economic Analysis of the Shuttle

To determine whether a system with the general characteristics and capabilities predicted for the shuttle should indeed become a reality (granted that it is technically feasible) requires that three basic questions be answered:

1. How much investment is required to reach the point of an operational capability?
2. How much will the shuttle reduce the cost of space activity?
3. Will there be enough useful space traffic to justify the large investment involved in obtaining these capabilities?

The first two questions relate to the relative costs and benefits of alternative space transportation systems. N.A.S.A. has given a great deal of attention to these questions over the past 18 months and has sponsored a series of analyses that show that the shuttle is indeed an economically sound investment in relation to a broad range of plausible models of space traffic for the 1978-1990 period.

Significantly less attention has been paid to the more fundamental question of whether the combined scientific, commercial, "applications", military, and political payoffs of such space activity are themselves sufficient to justify the overall investment they entail. With debate focused on the shuttle—a means to an end—there has been little detailed evaluation of the goals of the space program for the remainder of this century. However, N.A.S.A. leaders stress that the reasons for going ahead with the shuttle are not only that it is now a good

investment in terms of replacing expendable launch vehicles, but also that it provides a new capability for doing a wide variety of tasks in space which will be valuable to the United States and the world.

The most recent estimate of the cost of developing an operational fleet of four shuttle boosters and five orbiters (based on concurrent, not phased, development) is approximately $13 billion. By comparison, the cost of Project Apollo through the Apollo 15 mission is $22.9 billion. Apollo was justified as a demonstration of national strength and determination—a rationale hardly amenable to quantitative evaluation. For the shuttle, in contrast, N.A.S.A. has contracted for elaborate benefit-cost analyses, and the results of these analyses are the agency's prime weapon in attempting to build a case for the shuttle investment.

The most comprehensive economic analysis of alternative space transportation systems (which included, in addition to the shuttle, a relatively inexpensive "space tug" to move payloads from near-earth to geosynchronous orbit) has been performed under N.A.S.A. contract by the Princeton-based firm of Mathematica, Inc., which is headed by economist Oskar Morgenstern. Mathematica used as inputs the results of two other N.A.S.A.-funded studies on the effects of shuttle operation on the costs of payload design and an estimate of the volume and character of likely space traffic between 1978 and 1990 developed by N.A.S.A. and the Department of Defense. Mathematica used this baseline mission model to generate a variety of other possible scenarios for space activity during the same period. In all, 26 such scenarios were examined.

The table gives the results of a cost analysis of the baseline mission model, which presumes an average of 56 missions a year for the 13 years. Examining these figures, it becomes clear that payload costs, not launch vehicle costs, are the major expense of the space program, and that the shuttle lowers the overall costs of space operations not because it is the cheaper launch system but because of the reduction in payload costs that it permits (due primarily to the new-found ability to reuse, refurbish, and update satellites and their payloads. These payload savings would accrue even if N.A.S.A. adopted a phased approach to shuttle development, since only a reusable orbiter would be required to obtain them.)

To evaluate the size of investment that would be justifiable to obtain a reusable shuttle system, the Mathematica study used a 10-per-cent social discount rate (which is the interest charged to account for the diversion of funds to the shuttle from other possible uses). The study pointed out that the choice of a discount rate has a "major influence" on the economic analysis of a new project, one outweighing "many other important issues." The 10-per-cent rate used is a relatively high one, reflecting a belief that, because the shuttle program may have trouble gaining approval, it is necessary to demonstrate that the shuttle will be an economically sound investment under conservative assumptions. The Mathematica study concluded that buying a shuttle and associated space tug system, at a cost of almost $13 billion, was justified "provided that the United States intends to operate a space program with a number of

Space Program Costs (1978-1990) Using Current Expendable Launch Vehicles (56 launches per year)		Costs for Same Program Using Shuttle
Launch vehicle costs:		
Development	$ 1.54 billion	$12.80 billion
Operation	13.12 billion	5.51 billion
Total	$14.66 billion	$18.31 billion
Payload costs:		
Development	$12.38 billion	$10.07 billion
Operation	31.25 billion	15.79 billion
Total	$43.63 billion	$25.84 billion
Total Program Cost	$58.29 billion	$44.15 billion
Savings using shuttle: $14.14 billion		

"Payload costs, not launch vehicle costs, are the major expense of the space program," writes the author, "and the shuttle lowers the overall costs of space operations not because it is the cheaper launch system but because of the reduction in payload costs that it permits." This table shows the results of a cost analysis of one plausible national space program for the 1978-1990 period.

flights equal to the *unmanned* space program activities of the United States in the 1960's." This meant, said the study, that "the economic justification of a reusable Space Transportation System is independent of the question of manned versus unmanned space flight."

From N.A.S.A.'s viewpoint, this last conclusion is especially welcome, for it means that the agency can justify developing the shuttle without asking the country to support new manned programs; and that in the bargain N.A.S.A. will gain, essentially for free, the capability to resume an active manned program during the 1980's. But the Mathematica study is not a blanket endorsement of the shuttle program. In particular, the report repeatedly stresses that a demonstration of cost-effectiveness within the given framework is not a sufficient reason for proceeding with the shuttle's development. Rather, Mathematica emphasizes, "any investment can only be justified by its goals. . . . A new, reusable Space Transportation System should only be introduced if it can be shown, conclusively, what it is to be used for and that the intended uses are meaningful to those who have to appropriate the funds, and to those from whom the funds are raised, as well as to the various government agencies that undertake space activities." Mathematica criticizes N.A.S.A. for failing to work out a "firm program of sufficient detail" to provide the basis for such an evaluation. The report comments that this lack "is by far the weakest point in the entire N.A.S.A. effort, overshadowing the uncertainties in cost and timing" of the shuttle program.

The Shuttle and the Political Process

Decisions regarding the comparative worth of alternative uses of federal funds reflect concepts of national priorities and the national interest held by the politically powerful segments of our society. Both the Congress and the President are likely to pay increasing attention to the shuttle during the coming year with the President facing the decision this winter (assuming that N.A.S.A. requests it) whether to approve some type of shuttle program, reject it, or adopt some position between these two extremes.

The Congressional debate over the shuttle has not yet attracted wide public or interest-group attention. Of course, firms which are potential recipients of shuttle contracts are making their support of the program known at the White House and on Capitol Hill and to those who might influence government policy on this issue. McDonnell-Douglas, for example, earlier this year distributed a promotional pamphlet suggesting that "if we were to identify Shuttle as a national goal, as was Apollo's lunar landing program, it would provide an emphasis to ensure prompt Shuttle development and make it a vital point of national pride."

Little opposition to the shuttle was voiced during this year's House hearings and debates on the N.A.S.A. budget, in contrast to Representative Karth's attempt to block shuttle funding in 1970. An amendment deleting shuttle funds, offered by Representative Bella Abzug (D.-N.Y.), was defeated by a voice vote. (Karth this year "enthusiastically" supported the funds for shuttle studies, now that the shuttle was "separated from the large space station.")

Senator Mondale did reintroduce his anti-shuttle amendment during Senate consideration of N.A.S.A.'s authorization in June, but there were only 22 votes supporting it compared to 64 opposed. Mondale, seeing "no prospect for a change in that vote," decided that "there was no useful purpose" in calling for an anti-shuttle vote during the floor debate on the N.A.S.A. appropriation in July; but he did say that he plans "to press this issue next year."

Three scientists who have for some time been identified with those who favor an end to a manned space flight program but an active unmanned program—James Van Allen, Thomas Gold, and Brian O'Leary—spoke out against the shuttle both in 1970 and again this year, and the Federation of American Scientists came out against the shuttle in July. But it is difficult to anticipate the kind of widespread interest-group and public opposition to the shuttle that characterized the debate over the supersonic transport. Although opponents of the shuttle draw parallels between it and the S.S.T. as technological undertakings not responsive to priority needs, the environmental aspects which were the major catalyst of opposition to the S.S.T. are not present. N.A.S.A. can probably still draw on enough latent support for its programs to defuse a public groundswell against the shuttle, especially if the last two Apollo missions are as spectacularly successful as Apollo 15.

The substance of the shuttle debate to date does, however, bear a similarity to those over both the S.S.T. and the A.B.M. in that it is dominated by experts using technical information in a partisan fashion to support their own points of view. N.A.S.A. claims that the shuttle, with a non-recurring cost of almost $13 billion and a cost per launch of $4.6 million, represents a cost-effective launch system as long as there are a minimum of 40 launches per year. The cost of a shuttle launch, the agency points out, is almost $1 million less than the cost of launching a Thor-type expendable booster such as is now used for many civilian and military launches. Yet the shuttle will be able to orbit from 2.5 to over 25 tons of payload with each launch, while the Thor can orbit less than one ton.

Critics concentrate on the maximum payload capacity and ask what requirement there is to launch a thousand or more tons of payload into orbit each year when in 1969 N.A.S.A. launched a total of 191 tons of payload, including 185 tons in four Apollo manned missions. To those who still see the shuttle as the first element of a large manned program, this excess payload capability looks like the basis for a future N.A.S.A. justification of greatly increased space activity, including a large space station.

If the future space mission model developed by N.A.S.A. and the Department of Defense and used in Mathematica's analysis is valid, then the N.A.S.A. argument appears the more realistic, since economic analysis based on this model shows the shuttle cost-effective even when launched at far less than full payload capability.

The key phrase in the last paragraph is "if the future space mission model is valid." For this model reflects, in terms of a series of specific flights, the goals to be served by the space program of the 1980's and, by implication, the 1990's. Evaluating these goals and comparing them to other possible government undertakings is one essential task which should be faced by our nation's decision-makers before they authorize N.A.S.A. to proceed with the shuttle. This will be an extremely complex task, for the potential goals of space activity are not independent of the existence of a space shuttle; the interaction between the new capabilities and lower operating costs of the shuttle and the potential scientific, commercial, military, and political benefits of various space activities has not been carefully analyzed.

Benefits of a space program based on a shuttle capability are only one part of the balance which decision-makers must weigh; another is the cost of obtaining that capability. As has been mentioned several times, N.A.S.A. is now projecting about $13 billion as the cost of developing an operational shuttle fleet by 1978, if the orbiter and booster are developed concurrently. A comparable estimate of the costs of a phased approach to development will be available by the time the N.A.S.A. budget is set. But these are cost *projections*, and recent experience with the final costs of long-term, high-technology programs, including many N.A.S.A. and Department of Defense undertakings, provides little assurance that the actual cost of the shuttle will be within a few per cent of the projected cost. Yet there is little margin even now for growth in the development cost of the shuttle program; a total cost much above $15 billion is not likely to be economically sound or politically feasible.

A decision to embark on the shuttle program represents a national commitment to a technological enterprise rivaled in size and complexity only by the Manhattan and Apollo projects. N.A.S.A. believes that Congress is now willing to approve shuttle development funds next year, if President Nixon authorizes the agency to request them. The critical decision on going forward with the shuttle will be made in the White House sometime between the time N.A.S.A. submits its budget request for the next fiscal year and next January, when the President's budget decisions are made public.

To assist him in reaching a decision on the shuttle, President Nixon will draw on the advice of his Offices of Management and Budget and of Science and Technology, the President's Science Advisory Committee (P.S.A.C.) and the National Aeronautics and Space Council. P.S.A.C. has formed an *ad hoc* panel chaired by Alexander Flax, who heads the Institute for Defense Analyses, to develop its position regarding the future worth of the space program and the role of the shuttle in that program. P.S.A.C. has examined the shuttle before; in 1970 a P.S.A.C. report endorsed the concept, noting that "the most important advances in space exploration seem to rest on the development of the space transportation system" and that it was likely that "some form of reusable space transportation system will indeed become the most attractive major technology development for the decade" with the eventual potential "to usher in a new space era."

The present P.S.A.C. panel began its work in August and will report to the President through its parent committee in time for its views to be considered during this year's budget deliberations. Among the factors that this panel undoubtedly will have to consider are the validity of alternative mission-models for future space programs, the technological feasibility of current shuttle design projections, and the accuracy of N.A.S.A.'s estimates of the program's development and operating costs.

Last year the Office of Management and Budget (O.M.B.) reduced N.A.S.A.'s $190 million shuttle budget request to $100 million. O.M.B. did approve funds for the development of the shuttle engine, but the decision whether to allow N.A.S.A. to begin shuttle airframe development before mid-1972 was deferred pending the outcome of the shuttle design studies then (and still) underway. This approach was based on O.M.B.'s judgment that neither the technological nor the economic dimensions of the program had been sufficiently explored by last December to form a basis for a decision to begin airframe development. Although there has been a great deal more study of both dimensions since last year, many elements of the program are still far from firm. O.M.B. officials do say that they are prepared to consider a shuttle commitment this year, and that the economic dimensions, both in terms of short-term budgetary implications and of the relation between the program's long-term costs and benefits, will be the determining factor in their recommendations to the President. The O.M.B. is also interested in alternative N.A.S.A. programs for the rest of the decade, should a decision against starting the shuttle now be forthcoming.

Will the Shuttle Be Approved?

The American political process is poorly designed for making decisions involving near-term costs and long-term benefits. A President must face the electorate every four years; a Congressman every two or six. The pressure for immediate results is great. Programs like the shuttle, with payoffs 7 to 10 years in the future, often suffer when compared to those with more rapid benefits. Often short-term considerations have more influence on decisions concerning future government programs than might be justified if the governmental process followed a "rational" or "efficient" model.

Such is likely to be the case for the shuttle decision. The political and economic context of the next few months, and the imminence of next year's election, are likely to dominate Richard Nixon's thinking as he considers N.A.S.A.'s request for shuttle funds and the recommendations of his technical and budgetary advisers. The likely impact of these factors on the decision is far from clear. President Nixon personally is a space buff who identifies closely with astronauts, but his White House political advisers are far less enamoured of the N.A.S.A. mystique and believe that he can get little general political mileage out of his support for the space program. One particular source of political trouble during next year's campaign, however, may be the depressed condition of the aerospace industry, and a positive decision on the shuttle might eliminate much of that problem. President Nixon's August 15 announcement of major shifts in economy policy aimed at halting inflation and decreasing unemployment probably foreshadowed an extremely austere federal budget for the next fiscal year. If this turns out to be the case, then the President will have to determine his priorities within a constrained funding situation, and this will involve direct comparisons of the desirability of starting the shuttle program versus the need for programs in health, environmental improvement, housing, transportation, and the like, all of which are better bets to produce political benefits in next year's election.

It is hard to avoid the conclusion that, whatever the merits of the shuttle, this is the wrong year for N.A.S.A. to be asking for a decision to proceed with its development. The agency's decision last June to consider a phased approach to the program and to modify the orbiter design to accommodate expendable fuel tanks resulted in a hurried attempt to analyze and document the technical and economic implications of these changes in time for them to be reflected in the agency's October 1 request to the O.M.B. It seems that N.A.S.A. would have been better off if it had scheduled its shuttle study program so that the decision point on the shuttle was next year, not this.

But now N.A.S.A. has cranked up center and industry teams to study the shuttle, and it would be difficult and expensive, both for the agency and for the firms competing for the contracts, to keep those teams together for another year if the decision on the shuttle were to be deferred. Thus, although there is no strong technological or economic reason why the shuttle decision should be made at this time, organizational momentum is pressing for a decision this winter.

This composite picture of plan-position-indicator (P.P.I.) radar echoes from Hurricane Daisy (August, 1958) reveals the eye, the typical circular wall cloud surrounding it, and the rainbands spiralling toward it; the area shown covers just over 50 nautical miles in each direction from the center of the storm. Radar technology has for decades concentrated on eliminating such unwanted "interference" signals as those caused by rainfall. Thus radars now used for storm reconnaissance are inadequate to reveal all the important data needed for accurate forecasts of future strength and position. But the technology required for a comprehensive hurricane detection and surveillance system is known, and only the financial resources to realize the system are lacking. (Drawing: after J. Simpson, "Hurricane Modification Experiments" Proceedings of the Hurricane Symposium of the American Society for Oceanography, 1966.)

The average difference between the forecast location of a hurricane landfall 24 hours in advance and the location of the actual landfall is now about 100 miles—about equal to the size of an average hurricane. Better forecasting is clearly needed, and present technology fully utilized is entirely adequate to achieve it

by James W. Meyer
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Toward Hurricane Surveillance and Control

Hurricane Camille, the most damaging hurricane ever to strike the mainland of the United States, came ashore near Bay St. Louis, Miss., just before midnight on Sunday, August 12, 1969. In the next 24 hours she left in her wake hundreds of dead and destruction of property amounting to nearly $1.5 billion—the result of wind and surging tides on the Gulf Coast and of flooding by torrential rains extending into the western Virginias. A year later, Celia, born in the Caribbean on nearly the same spot as Camille, ravaged the Texas coast around the small fishing town of Aransas Pass. Celia, a "dry" storm, produced relatively little rainfall, but gusting winds with unexpectedly high peak speeds caused about $250 million damage in Corpus Christi, Texas, alone.

Camille and Celia are only recent examples, not unique, of storms that have battered the Caribbean and the U.S. Atlantic and Gulf Coasts throughout history. Comparable killer storms occur in the Pacific and Indian Oceans; only in the South Atlantic have orographic features prevented tropical storms from forming. We have a global problem; there obviously is great need to better understand the dynamics of the storms, to predict accurately their striking points and intensities, and to learn how to modify them.

It is the thesis of this article, which summarizes the conclusions of a special summer study in M.I.T.'s Lincoln Laboratory in 1970, that much of the information needed to accomplish these important goals can be obtained through effective use of advanced airborne radar systems.

The Tropical Storm

"Tropical cyclone" is the generic name for vortical circulations originating over tropical waters. When well-formed and producing surface winds of 64 knots or more, tropical cyclones are called hurricanes in the Atlantic, typhoons in the North Pacific, baguios in the Philippines, Bengal cyclones in the Indian Ocean, and willy-willies in parts of Australia. (When winds are between 34 and 63 knots, the official name applied in the U.S. is "tropical storm.")

Most tropical cyclones develop from wave disturbances caused by the convergence of air masses near the Equator in regions far from land. Many hurricane "seedlings" are now observed at birth by satellites—often over the Sahara Desert. These tropical depressions or pressure troughs may extend 1,000 nautical miles. Driven by trade winds at speeds up to 10 knots, they proceed west-by-northwest—those from the Sahara taking days to cross the Atlantic, gaining strength, and then to penetrate the Caribbean or to "recurve" to the northeast along the Atlantic seaboard in response to the prevailing westerlies. About one seedling in 10 develops into a major tropical storm.

June through November is the nominal hurricane season for the Atlantic and Gulf Coasts. Early in the season, tropical storms develop to hurricane strengths principally in the Caribbean and the Gulf of Mexico. Later, principal areas of development shift southeastward, from the Bahamas and Lesser Antilles to the Cape Verde Islands. Late in the season, origins shift back into the western Caribbean and Gulf of Mexico. This whole area covers some 22 million sq. mi., much of which is accessible to surveillance and measurements only by satellites and aircraft.

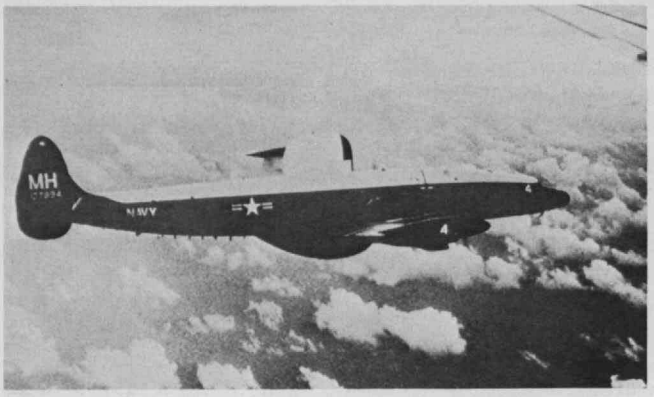
In an average year the Atlantic and Caribbean experience 8.0 tropical cyclones; of these 4.8 will develop into full-fledged hurricanes, often causing damage of over $100 million and killing 50 to 100 persons. In a bad year, damage will exceed $1 billion and deaths will run in the hundreds.

Hurricane Reconnaissance and Warning

From the time a tropical depression is discovered to the point where shore-based radars are able to see the storm, airborne reconnaissance is now used to establish its position, to measure the lowest sea-level pressure, and to find the maximum surface winds. Meteorological satellites—some orbiting, some geostationary—keep full-time watch for suspicious-looking tropical disturbances. On-the-spot investigation by aircraft determines the nature of the threat, and all these observations are communicated to the National Weather Service's National Hurricane Center in Miami, the focal point for forecasting and warning.

Hurricane reconnaissance by aircraft of the Air Force, the Navy, and the National Weather Service's Research Flight Facility follows a National Hurricane Operations Plan, worked out and mutually agreed upon by the participants. For this purpose, the Air Force uses WC-130 Hercules aircraft, the Navy WC-121N Constellations, and the R.F.F. a converted DC-6B. None of these aircraft has a radar system designed specifically for hurricane reconnaissance. The Navy plane uses an

These three aircraft are in use for hurricane reconnaissance today. The Navy's WC-121N (Constellation) (top) has the best radar in current use for plan-position display of hurricane structures from over 200 miles from the storm center; a powerful 3-cm. radar is used for R.H.I. (range-height indicator, displaying a "vertical slice" of a storm) information. The Air Force turboprop WC-130 (center), equipped with 3-cm. weather-avoidance radar, is the most modern aircraft of the fleet, able to penetrate the most severe storms. The National Weather Service's Research Flight Facility uses a converted DC-6 (below), equipped with 3-, 5-, and 10-cm. radars and advanced meteorological instrumentation.



APS-20 radar designed during World War II to provide early warning of bomber attacks; it not only gives a broad view of the storm but helps the pilot pick a path through the tempest for a close-up look with meteorological instruments. The Air Force uses a weather-avoidance radar, and the R.F.F. uses an adaptation of the APS-20 radar plus special configurations of two commercial radars.

Only minimal research and development effort is now devoted to airborne radar for storm reconnaissance, even as we see our adaptations accomplish so much and promise much more in such specialized operations. All but a few research radars in use today, even on land, are "hand-me-down" systems originally designed for quite different purposes and only adapted for hurricane reconnaissance.

Hurricane Reconnaissance Problems

Camille focused national attention on the limitations of our ability to detect, analyze, track, and forecast hurricanes and to disseminate credible warnings of severe storms. A survey team of the Environmental Science Services Administration (now the National Oceanic and Atmospheric Administration) has described in detail the dreadful saga of this killer storm, whose winds gusted to nearly 200 miles an hour causing tides 15 to 30 ft. above normal along the Gulf Coast east of the eye.

A Navy reconnaissance plane was dispatched from Jacksonville, Fla., on Thursday morning, August 14, 1969, to investigate a suspicious disturbance. The pilot discovered Camille 400 miles south of Miami and 60 miles west of Grand Cayman Island. This tropical depression grew with remarkable speed to reach storm intensity even while the Navy aircraft was still circling the area.

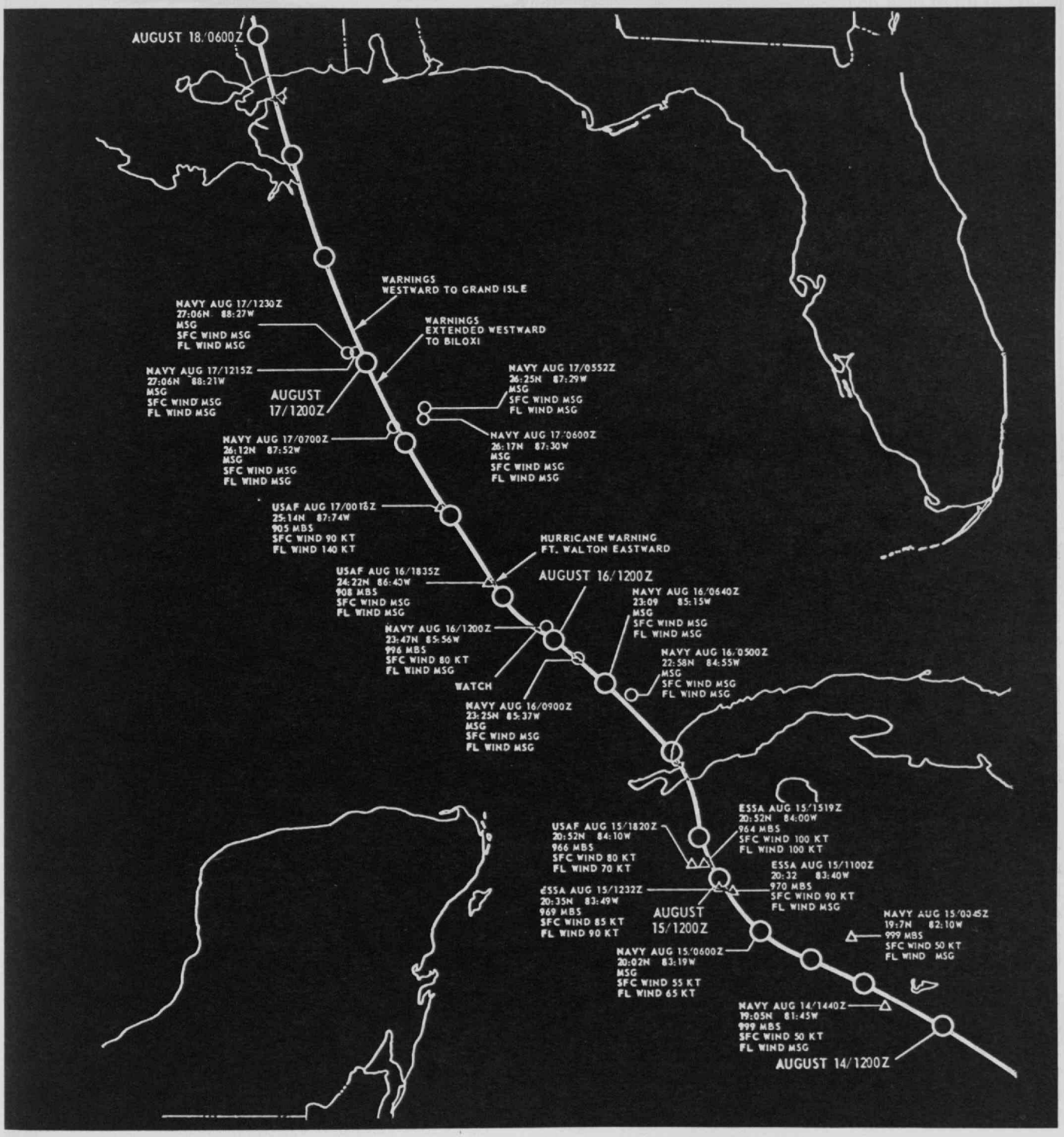
Thereafter, Camille was watched as carefully as possible, and the accompanying chart provides an *ex post facto* summary of all the reconnaissance data as it became available. Uncertainty in information concerning the location of the eye clearly confused the forecasters and led to uncertainty regarding Camille's probable landfall. Such confusion may in fact be inevitable in view of the erratic path which some hurricanes take; but it is also true that the eye is sometimes difficult to identify accurately with today's radar equipment from many miles outside the storm, and the true storm center —which is not necessarily synonymous with the eye—is sometimes very hard to locate. It is clear that in Camille's case too few planes were available to provide continuous and/or complementary coverage at critical junctures during the storm's life. Early in this period, for example, one mission had to be aborted because of radar failure.

In the E.S.S.A. survey team's report on Camille, there were two top-priority recommendations:

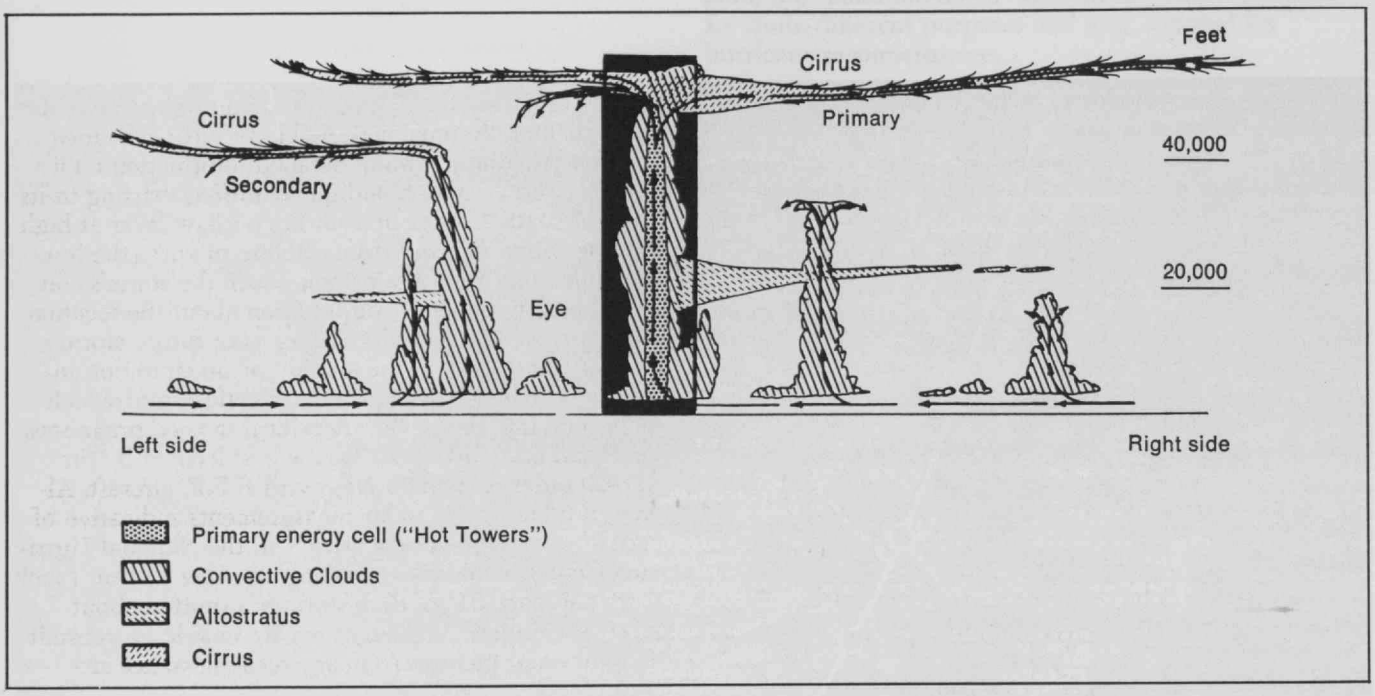
☐ Improve public education and community preparedness programs.

☐ Improve aircraft reconnaissance.—It was noted, for example, that the Navy needs better aircraft, the Air Force needs better radar, and the Research Flight Facility could use both a better aircraft and better radars. (All three now have minimal programs designed to overcome some of these problems.)

The severe destruction wrought by Hurricane Camille in August, 1969, focused attention on the need for improved hurricane warning services. This chart, taken from a survey report of the Environmental Science Services Administration, summarizes the reconnaissance data which was available to forecasters as the storm crossed the Gulf of Mexico from the Caribbean. The large circles represent the smoothed track based on six-hour estimates of eye locations using all available data; the small circles represent the points at which surveillance aircraft located the eye of the storm at the times indicated. For example, an Air Force aircraft at one point reported (accurately) a central pressure in the eye taken with a dropsonde which was so low as to be hardly believable. Communication problems made it impossible to ask for a corroborative run before the National Hurricane Center had to issue a warning. Earlier, uncertainty in information concerning the location of the eye suggested to the forecasters a northeastward curve which never materialized. The data on the map are given in the following sequence: aircraft and time of measurement; position; atmospheric pressure in millibars; wind velocity at the ocean surface; and wind velocity at flight level. MSG is the abbreviation for "missing."



Though every hurricane is different and though we lack a general picture of wind, temperature, water vapor, and rain distribution, ten years of hurricane research have yielded this model of a typical hurricane structure. The motion of the storm, as seen in this cross-section drawing, is away from the viewer, with the primary energy cell to the right (north or east in the northern hemisphere) of the eye and the primary cirrus extending to the right and left from its top. Elsewhere the eye is defined by the ring of secondary energy cells with its secondary cirrus development, and the spiral bands of rainfall show in cross-section as other smaller cells on each side of the eye. The "chimney cloud" region (in black) contains the strongest energy and heaviest rainfall. (Drawing: after J. Simpson, "Hurricane Modification Experiments")



A Hurricane Model

Very few hurricanes have been measured in detail, and every hurricane seems to differ in some respects from all others. So we lack a general picture of the wind, temperature, water vapor, and rain (hydrometeor) distribution in time and space. Consequently, detailed meteorological models of hurricane structure are not available. But a physical description of a "typical" hurricane can be attempted from the few measurements available.

As seen on a radar P.P.I. display (*see p. 58*), a hurricane consists of several rain-band echoes that spiral into a central, generally circular, echo-free region. The echo-free region or radar eye usually coincides with the central calm low-pressure eye of the hurricane. A wall of clouds, surrounding the eye, contains large cells about 20 km. thick, and it is in this eye-wall region that the highest horizontal and vertical wind speeds occur. Very heavy rainfall—often exceeding 6 in./hr.—can occur in one or a few small cells 5 to 10 km. wide and 10 to 15 km. high. Other rain cells form spiral bands which converge on the storm center from distances out to 150 km. Outer spiral bands show less rainfall than in the large cell areas, of the order of 0.4 in./hr.—rates which decrease to less than 0.1 in./hr. near the edges. These bands can, however, contain small convective rain cells only about 1 km. wide in which rainfall can be heavy. Rain in the low-rainfall-intensity areas usually originates from snow which turns to rain at the melting level, producing what radar meteorologists call the "bright band" because the radar cross section of the melting, water-coated snowflakes is usually 4 to 10 times that of the droplets which emerge beneath it.

In a simplistic view, a hurricane may be likened to a heat engine operating between a warm source—the tropical ocean—and a cold sink—the upper atmosphere. Inflowing warm air drawn over the tropical ocean rises to release its moisture as rain. The release of the heat of condensation provides still more buoyancy, and the warm air rises to even higher levels, encountering lower temperatures and producing still greater output from the heat engine.

Current Forecasting Techniques

Storm forecasting techniques used at present by the National Hurricane Center are generally empirical in nature, the result of years of diagnostic work on all the storms for which even a modest amount of data are

available. Experience and judgment are the forecaster's principal tools; experience allows him to pull out of the past a set of similar meteorological circumstances, and judgment permits him to filter the elements of raw data he receives. Accurate location and tracking of the storm center are important because storm-track forecasts are ordinarily based on simple projections of past position and motion into the future. Greatly simplified models of the tropical atmosphere have been devised to permit predictions of storm development on the basis of how the model reacts to the insertion of measured or extrapolated meteorological parameters. The models have to be simple and the parameters few to be tractable on even large computing machines; but if the model is oversimplified it may fail to represent a true enough picture of the atmosphere to help with forecasting.

Some storms are simpler to forecast—because of their structure, location, or stability, for example—than others. The several models generally agree on predictions for a storm that is easy to forecast. But numerical forecasting models are not yet sufficiently sophisticated and reliable to help forecast problem storms, and the models are often at odds on the hard ones.

To translate what radar can measure into what the meteorologist needs to know about a disturbance in order to make a useful forecast, we need a radar model of a hurricane. Such radar models differ from the meteorological models on which they are based by including an allowance for how the radar "sees" meteorological phenomena. The National Hurricane Center will attempt during the next five years to automate the analysis of meteorological data that reveal the character of a storm's circulations, indicate their potential for development, and reveal any trend in storm movement.

Thus research will continue to improve the forecasting and warning services which assess the threat of hurricanes. One approach is the use of fluid-mechanical atmospheric models soluble on digital computers, which can then be used for forecasting in real time. As this work is perfected, the need for atmospheric boundary values over large regions will be urgent. For example, data obtained from reconnaissance aircraft and conventional surface maps have been used by Frederick Sanders, Professor of Meteorology at M.I.T., to successfully predict the track of one hurricane by a procedure of direct analysis, and preliminary tests indicate reasonable success in forecasting the tracks of a wide variety of tropical storms. The *ex post facto* predictions of the track of Hurricane Camille using this technique were remarkably successful.

The data needed for this kind of forecasting include the windfield averaged over the first 50,000 feet of altitude, the calculation of a stream function for this windfield, and barotropic predictions for 72 hours. As we learn more about how to "cool" severe storms with seeding techniques, there will be even heavier demands for storm data—both general observations provided by satellites and details provided by airborne reconnaissance. Though satellites have immense potential for picking out "trouble spots," only aircraft can provide the detailed measurements of storm parameters necessary for modelling and forecasting.

N.H.C. forecasters now work with four computer-generated charts, which display important parameters of a simplified two-layer tropical atmosphere bounded by the eastern Pacific (120° W.), the African Coast (10° W.), and latitudes 45° N. and 20° S. This is a vast area with many voids, where data are simply not available; these are judiciously filled in by a kind of interpolation and extrapolation from real data points. Two of the charts show mean winds in 200- and 400-millibar layers, from 1,000 to 600 mb. and from 600 to 200 mb., and two describe winds at the upper and lower bounds—at 200 mb. and at 3,000 ft. above the ocean surface. A number of computer subroutines permit extraction of other derivative information from the four basic charts.

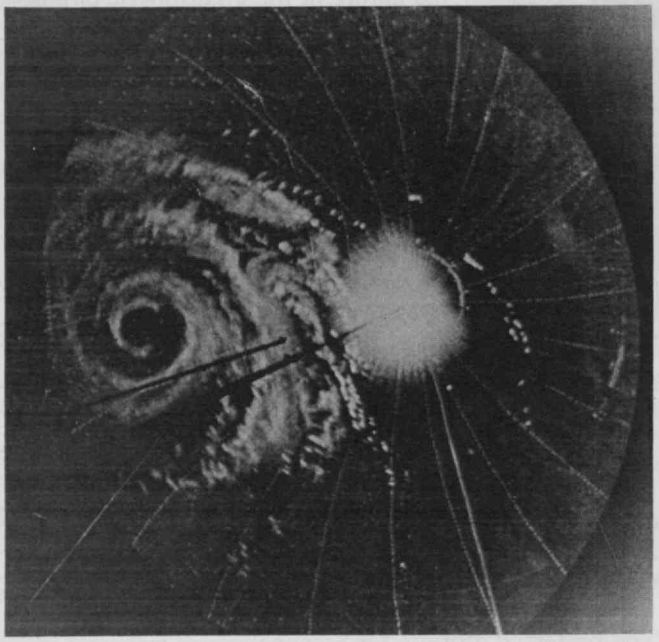
Since 1970, these charts have been supplemented by data from the ATS-3 satellites which help to fill in voids where previously the nature of the atmospheric circulation was literally unknown. Airborne reconnaissance remains essential to obtain detailed information on a storm's internal motion and on conditions existing in its probable path. Clouds in a storm's outflow layer at high altitudes often obscure from satellite pictures the low-level inflow of tropical air upon which the storm's continued energy depends. Information about the location of this inflow is essential to forecasts of future storm intensity, and data on the amount of precipitation in the feeder band clouds and the direction from which they spiral into the vortex are critical to good prognoses. The band of inflowing air is now best located by the APS-20 radar carried on Navy and R.F.F. aircraft. Although quantitative radar measurements indicative of rainfall rates are not now asked for, the National Hurricane Center would like a radar plan view picture (such as that on page 64) of each storm transmitted about every 30 minutes. At present we are unable to transmit in-flight radar pictures from any reconnaissance aircraft.

The preferred altitude for reconnaissance traverses of a hurricane is from 10,000 to 14,000 feet. In a well-formed, stable storm, winds measured at this level in the circle of maximum winds will be within 5 per cent of those at lower levels; and at 10,000 feet there is less physical danger to the aircraft from destructive gusts (higher altitudes) or extreme downdrafts from heavy precipitation (lower altitudes). In an unsteady storm the preferred reconnaissance level is at the base of the clouds or, alternatively, at the base of the outflow layer. Reconnaissance plans emphasize gradients of meteorological parameters—not point values at a single flight level—because these gradients better display the configuration over a broad area.

All of the measurements called for provide together only an indirect way of measuring maximum winds in the storm and the radius of the circle over which such winds extend—the two parameters which together indicate the fury of the storm and the area endangered.

A number of reference points which may be considered as the storm's center are commonly specified—the position of lowest central pressure, the center of the ring of maximum winds, the center of the eye-wall clouds, or the center of the radar eye for examples—and they may or may not be coincident. Only the radar cen-

The most versatile radar now available for hurricane surveillance is the Navy's APS-20, carried by World-War-II-vintage Constellation aircraft. It records the presence and location of an eye and the major structural features—including spiralling rain bands—of the storm; and, if surveys are repeated at three- or six-hour intervals, much can be learned about the movement of the eye and development of the storm. But this equipment gives no quantitative measure of rainfall or wind velocity.



ter can be located from outside the storm, and, when storms are beyond the range of shore-based radars, only the APS-20 among current radars provides this display. (Land-based radars can detect severe storms at ranges of about 250 miles. At present, these radars give range and track information quantitatively and information on rainfall intensity only qualitatively.)

Airborne Weather Radar Design

The design of an airborne weather reconnaissance radar poses unique problems, and it is fair to say present-day operations gain little advantage from the well developed state-of-the-art of radar technology. Indeed, it is ironic that the design of a radar to *probe* the weather should be so ill-advanced when elimination of unwanted weather echoes has been a major problem—largely conquered—in designing radars for other purposes!

The principal targets to be "seen" by a weather radar are water droplets; these range in size from those encountered in heavy tropical rain to those that make up cloud formations. A sensitive radar can also see such ice particles as hail, the fine crystals in cirrus clouds, and snowflakes. The process is, of course, the same as that involved in obtaining any radar echo. A brief pulse of radio waves is transmitted by the radar, which then receives and analyzes the reflection of that pulse from whatever objects, including water or ice droplets, it encounters. The time elapsed between transmission and reception is directly proportional to the distance between radar and reflector.

The radar echo from a cloud or rain cell is to be considered as the composite result of the scattering of the individual drops within the radar resolution volume —that is, the volume bounded in width and elevation by the narrow radar antenna beam and in depth by the effective length of the radar pulse. Because meteorological targets usually extend beyond this resolution volume, the echo signal intensity at the radar receiver varies inversely only with the square of the target range rather than the familiar inverse fourth-power law found for radars observing small or "point" targets.

In case of water droplets, when the size of the drop is small relative to the wavelength of the radar by which it is "seen," the strength of the radar reflection depends strongly upon the diameter of the drop; but as wavelength increases, echo strength from a drop of any given size decreases nearly as rapidly as it increases with drop size. This suggests that a very-short-wavelength radar, giving a strong echo from a small area of sky, is best for detecting rain and clouds. Such short-wave-length radars offer another important advantage, as well: they allow achievement of good angular resolution with a relatively small antenna. For these reasons, weather-avoidance radars which serve so well to make air travel safe and comfortable are designed to operate in the 2- to 5-cm. wavelength region.

However, short wavelengths have an important disadvantage for storm surveillance. If we wish to look inside a storm and to study it in detail with radar, the attenuation of the radar signal by any intervening weather is an important consideration, and this attenuation increases as the wavelength becomes smaller. Thus surveillance radar designers are forced into a compromise, and it turns out that a 10-cm. radar does well in penetrating into the depths of a hurricane without excessive attenuation in storm fringes by the rainfall patterns which exist there. Indeed, the 10-cm. wavelength is attractive from all aspects except the problem of mounting a large enough antenna. Mounting large scanning antennas on aircraft is especially difficult; and planes carrying them usually have the awkward and inefficient bulges which lead them to be called "guppies."

Extremes of rainfall are of special interest in the design of an airborne weather radar. The minimum rainfall rate expected establishes the required radar sensitivity; and the area occupied by the eye-wall cells and their maximum expected rainfall intensity establish the attenuation of radar signal through which lesser rainfall must be seen.

The airborne radar equipped to give only a qualitative display of a plan view of a storm such as that produced by the APS-20 can give the forecaster much of the information he needs: the presence and location of an eye and the nature of its structure—open or

closed; the motion of the storm (assuming that separate fixes are obtained a few hours apart); and the location of the major feeder rain bands spiraling into the storm. The same radar provides useful navigation information to the aircraft penetrating the storm. If the sea is visible, surface winds can be estimated by the aircraft pilot from the observed sea state. If the aircraft can penetrate the eye, and if it is also equipped with a range-height indicator radar, a vertical section of the hurricane from within the eye can be displayed which gives a corroborative indication of the intensity of the storm by showing the height of the eye-wall clouds. The Navy Constellation aircraft can do all these things.

But both the "Connie" and its radar are obsolescent if not obsolete. The radar, designed during World War II, saw its last production in 1958. As the equipment ages its maintenance becomes increasingly difficult, and the ratio of flying to maintenance hours is likely to grow smaller and smaller. The Navy the P-3 Orion, now in current inventory, more than adequately meets the requirements for hurricane service; but it appears impossible to mount a radar antenna on the P-3 that is more than two-thirds the size of that on the "Connie." We therefore cannot expect to receive from this equipment the radar performance we have enjoyed heretofore. The performance of the APS-20 radar on the R.F.F.'s DC-6 has also suffered from the necessity of mounting too small an antenna.

Recommended Modifications and Improvements

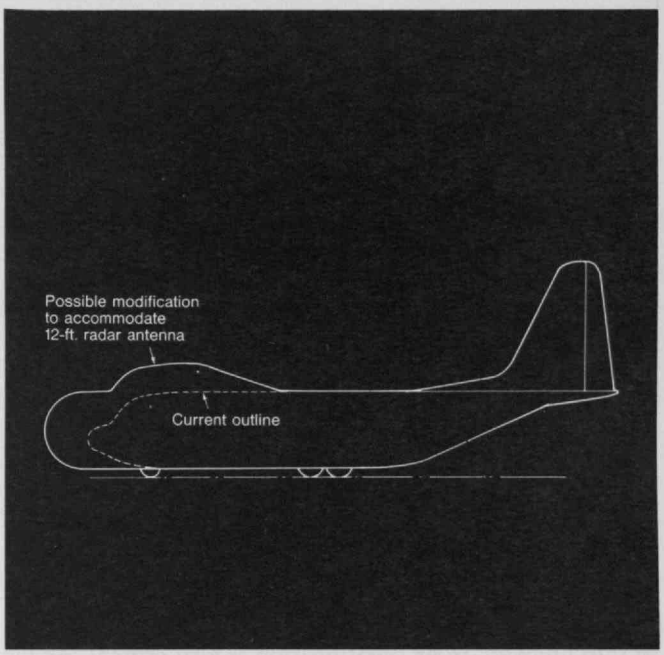
But major improvements in hurricane reconnaissance can be realized if radar techniques which are well within the state of the art and an airframe suitable for mounting a large antenna are brought to bear on the problem. A radar especially designed to make quantitative measurements can indicate rainfall rates and rainfall distribution; this can be done by simple automatic computations using distance as one of two unknowns contributing to echo intensity; rainfall intensity is the other. A Doppler radar system can measure relative velocities of the raindrops, such velocities being indicative of winds and updrafts and providing a more direct measure of the strength of the storm.

No airborne weather radar now operational can obtain such quantitative data on rainfall intensity and relative velocity while also recording cloud-top height and other storm parameters. Yet such data are essential to meteorologists concerned with developing storm models and improved forecasting techniques. These quantitative data, plus sea-surface temperature, are needed to supplement measurements currently made by storm-penetrating reconnaissance aircraft.

For the long term, it is essential that an instrumented severe-storm reconnaissance aircraft be designed from the overall systems point of view. The radar, for example, cannot be treated as an isolated problem because so much of what it must do—including observations needed, data reduction required, navigation demands, communications, and other factors—depends upon airframe and operational constraints.

The importance of an automatic, integrated, reliable navigation system cannot be overemphasized. Airborne Doppler navigation systems fail in heavy rain; inertial

The Air Force WC-130 turboprop aircraft could be modified as shown to permit installation of a large forward-looking antenna—a significant improvement in its instrumentation if not in its aerodynamics.



systems would offer great improvement. An on-board data-reduction facility and suitable data-formatting and recording facilities should be available to store information obtained on airborne reconnaissance missions so that it will be most useful to those studying the meteorological dynamics of severe storms.

Real-time communications between the reconnaissance aircraft and its data users are essential. Data such as radar altitude, pressure, humidity, aircraft position, wind velocity, dropsonde measurements, etc., should be immediately available to the National Hurricane Center. A satellite communication link could provide many possibilities—data, plan maps, rainfall maps, etc.—in addition to reliable voice communications.

We have been discussing airborne radar storm reconnaissance from the point of view of observing the storm from the side. None of the aircraft, nor any of the proposed replacements, can fly high enough to take any other view. The tops of fully developed hurricanes can exceed 50,000 ft. Above them the air is relatively calm. The aircraft that cannot fly above the storm has no alternative but to penetrate the eye wall to obtain atmospheric pressure data in the eye.

Because of the hazards inherent in penetrating severe

storms, we should seek means to locate and assess the severity of a storm from the outside. A storm-reconnaissance aircraft capable of operating at altitudes from 50,000 to 60,000 feet would offer an ideal solution to this problem. At these altitudes, well above the turbulence of the storm, the plane's equipment could map the storm in three dimensions, locate its eye, and measure winds and updrafts with a Doppler weather radar which for the most part looks downward. The radar detection ranges required of the downward-looking system would be less than a tenth those needed for the plan view. Moreover, the particles hardest to detect—ice, snow, and fine water droplets—are high in the storm and hence closest to the aircraft. Raindrops develop to their maximum size at lower altitudes, and they would be at longer ranges for a high-altitude radar.

The Case for Storm Modification

How important and practical is storm modification? The hurricane is simply far too strong to be fought head-on. Current approaches to modification involve seeding of outer rain clouds to cause premature precipitation which, in effect, spreads the release of latent heat and, hence, spreads the storm.

We are just beginning to understand the ingredients of effective hurricane modification. Although hurricanes occur far too often in terms of national safety, they occur all too seldom in the right place and at the right time for seeding experiments. It is difficult for researchers to know how effective their seeding has been when operating over the open ocean where there are no rain gages. In fact, there are few places over land where conventional rain gages are installed in adequate numbers to provide such assessments. Airborne radars capable of making quantitative measurements can provide rain-rate information over the broad area within their view. Because seeding is most effective in clouds about to rain anyway, their identification is also crucial. As we learn more about how to "cool" severe storms with seeding techniques, there will be even heavier demands for storm data—both general observations provided by satellites and details provided by airborne reconnaissance.

All these factors combine to suggest that we need a highly mobile, wide-ranging modification system ready and equipped to do its work wherever and whenever a good candidate storm develops. The elements of this system should include satellites, aircraft, ships, submarines, and land stations, all appropriately coupled with direct and reliable communications, able to guide the numerous participating elements to the right spot at just the right time. These operations would require all the flexibility and power of a highly coordinated military attack.

It will never be reasonable to try to nip all hurricanes in the bud, to use modification techniques while every storm is still in the seedling stage. This is because we depend on tropical storms to provide much of the annual rainfall on the country's eastern seaboard. There have even been hurricanes where the benefits of drought-breaking rainfall have outweighed the damage caused by the hurricane winds. For these and other reasons, workers in hurricane modification face many non-technical hazards, and no simple, automatic applications of technology—even if known—are conceivable.

Because we are presently unable to effectively modify—or even moderate—hurricanes routinely, we can only hope to save lives by evacuation and to reduce damage by protective measures. Both require credible and timely warning. The current average 24-hour forecast displacement error—the difference between the forecast location of a hurricane landfall 24 hours in advance and the location of the actual landfall—is about 100 miles, about equal to the size of an average hurricane; the ratio of warned to affected areas is, on the average, about three. This means that there is a minimum overwarning now of some 200 mi. Fortunately, the kind of airborne measurements needed for improved forecasting and warning are precisely those that can help in our long-range quest for control. Both being within our grasp with modest investment in new equipment but essentially none in new, less predictable technology, the author and his colleagues in the summer study recommended prompt action to achieve both short- and long-term goals outlined above.

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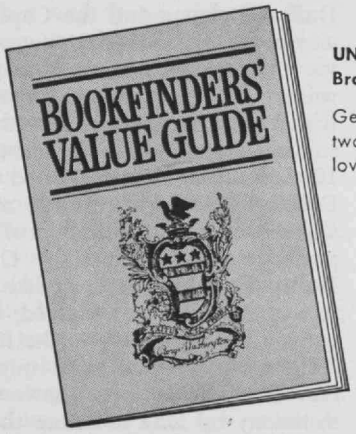

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Trend of Affairs

TRANSPORTATION

On a Thin Cushion of Air

The San Diego Freeway sweeps around Los Angeles through some pretty, hilly country—through the suburbs of the San Fernando Valley, past Los Angeles International Airport, and on to San Diego. The Airport, surrounded by urban Los Angeles, receives 21 million passengers a year who come and go on freeways like the San Diego.

The freeway heads roughly north from Los Angeles, a short part of the distance toward a new international jetport planned by the Los Angeles Department of Airports (L.A.D.O.A.) at Palmdale. The run along the freeway from the Airport to the San Fernando Valley, then, seemed a logical place to try out a new piece of technology, and the L.A.D.O.A announced many months ago that it intended, in cooperation with the Department of Transportation, to build a demonstration tracked-air-cushion-vehicle (T.A.C.V.) system to transport the 13 per cent of the airport traffic that comes from the Valley. The T.A.C.V., D.O.T. hopes, will eventually prove itself an alternative to the airplane for medium-length trips and will be useful for short trans-urban journeys such as this.

Last winter, William Rhine of the Department of Transportation's Transportation Systems Center (T.S.C.), described the plans at an M.I.T. seminar. The T.A.C.V. system would be built and demonstrable by December, 1972, and would begin carrying its first passengers in July, 1973. Its vehicles would ride cushions of air upon a guideway some dozen yards above the freeway, propelled by linear electromagnetic induction. It would average 80 m.p.h., reaching 150 m.p.h, its top speed, for eight per cent of its route, and the 16.4-mile trip would take 11 minutes non-stop and 13.75 minutes with a one-minute pick-up at Wilshire Boulevard.

D.O.T.'s Office of High Speed Ground Transportation had underway two corollary programs: building and testing linear-induction-powered vehicles and a preliminary tracked air-cushion one. A test track being built at Pueblo, Colo., would give space for full-scale research. The director of that office, Edward Ward, described the progress of these projects late last spring at M.I.T. The design of the T.A.C.V. that would eventually see passenger service was far from decided, he said. A small, wheeled, linear-induction vehicle had already made a few runs, and in late May would reach 100 m.p.h. on the first piece of the track built at Pueblo. During the summer, a T.A.C.V. being built by Grumman would begin to test the air-cushion concept. This first T.A.C.V. would have no space for passengers; it would carry turbofan engines to provide the air cushion. The production T.A.C.V. would result from this and subsequent test vehicles.

The Promise—and the Problems

D.O.T. projected that when the Los Angeles T.A.C.V. began service, at $2.50 a ride, in July, 1973, it would carry 1,000 passengers in a peak hour and 14,000 a day. By 1977, the load would be 22,000 a day—63 per cent of the airport passengers who live near the Wilshire intersection or in the Valley. Headways would range from 10 minutes down to six or less. The cost of acquiring rights-of-way, of building the guideway, stations, and vehicles, and of providing the electrical units was estimated to be $85 million; most of this money would be put up by the Los Angeles Department of Airports and the airlines using the Airport, a lesser share by D.O.T.

When the Los Angeles T.A.C.V. project was announced, and when it was described by Mr. Rhine last winter, much of the system was undesigned: the size and shape of the car and of the guideway (whether it would be a U- or T-shaped), for example. Plans for the automatic control and guidance mechanisms were not complete. Whether the power would be of stepped or variable voltage—and how much power the car would draw—were to be decided partly at Pueblo.

Shelved—and Shelved Again

Also problematical were the facilities that passengers would find at the stations: there was planned parking for 1,000 cars at the Dam—and no space for more; no feeder bus service was to be offered. A link with the Los Angeles subway is planned at Wilshire—if the subway is ever built. No improvement on the once-hourly collections by Valley busses was planned.

By the first weeks of 1971, the cost figure was revised to $135 million. Then came spare announcements that the project had been shelved, at least temporarily. The jetport at Palmdale was similarly put off. One source familiar with the L.A. project said that the airlines were no longer willing to support the line at the higher cost. D.O.T. adds that possible effects of an earthquake upon T.A.C.V. operation ought to be further explored—apparently a danger brought to their attention in February.

Then D.O.T. announced plans for another urban T.A.C.V.—this time for Washington, D.C.—which it said would help debug the one for Los Angeles. It would run a seven-mile course from the intersection of the Dulles Highway and the Capitol Beltway along the Dulles Highway to Dulles International Airport. A parking lot was to be built at the intersection, which will also be served by the Metro subway system when it is finished in 1976. *Railway Age* suggested that the Dulles T.A.C.V., to cost $25 million in all, was to spice the May, 1972, transportation show planned by D.O.T. at Dulles. But this T.A.C.V., like the one in Los Angeles, was shelved, and will enliven the show only in the form of a scale model. Other cities might offer the T.A.C.V. a bed, however, and testimony by D.O.T. before the House Committee on Appropriations suggested Houston and Kansas City.

A Cheap Alternative To Airports

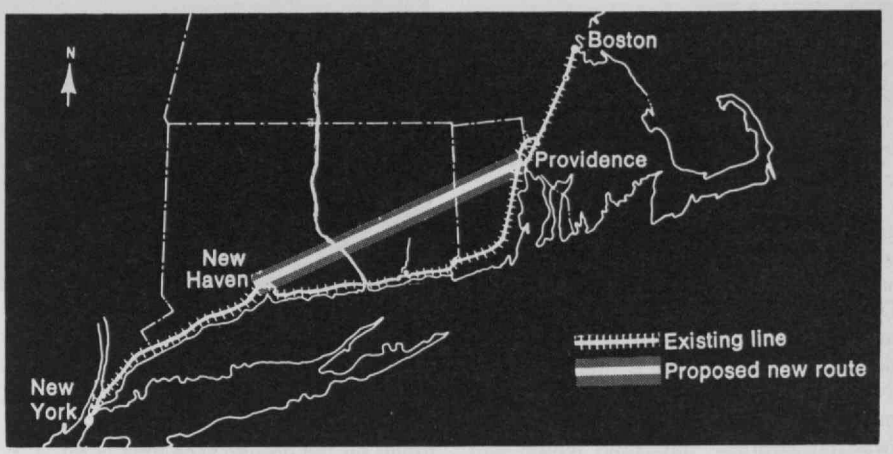
It's a fifteen-minute-ride to the airport from the center of Boston. Then you wait 10, 20, 30 minutes until the plane is in the air. An hour or so flying time, and another 10 or 20 minutes out of the airport in New York. Reaching downtown New York is another 30-minute (optimistic) chunk. Easily a fragmented two-hour waste of time. If you could get on a fast, clean, dependable train in the middle of Boston and emerge three hours later in the middle of New York . . .

By 1976, if all goes as the Department of Transportation hopes, that train will run, and it will carry—according to an independent study—over two million passengers a year. In mid-September, D.O.T. announced its intention to ask Congress for $460 million, probably as additional loan guarantees for Amtrak, to renew the rail lines between Boston, New York, and Washington.

The money will go to improve the existing line, for the most part. The Boston-New York line will be electrified, to carry the Metroliner service now used between New York and Washington. The rail bed, will be straightened and the rails themselves replaced with welded ones, to support a smoother and faster ride—perhaps with a top speed of 120 m.p.h. New signaling devices for the cab and new grade-crossing equipment will be installed as well. Some $80 million will buy a new fleet of trains.

The line between New York and Washington is already electrified; the half of the $460 million devoted to this segment will refurbish the Metroliner cars now in use, straighten and improve the roadbed, clean up the terminals, and make trains more frequent.

D.O.T.'s plan is to spend about $1 billion on transportation in the Northeast Corridor in the next few years. A second major highway, parallel to I-95, will be built, for $190 million, by connecting and improving present roads (with an information system to tell drivers about road conditions). The Department would also like to commit $500 million to investigating the best ground system for the 1980's—apparently favoring some sort of "levitated" vehicle, probably a T.A.C.V.



What now takes four hours—plus—might take only two, if a direct line were built from New Haven to Providence and the rest of the line improved (at a total cost of $690 million, according to the Geo-transport Foundation of New England, which made its study with help from the M.I.T. Urban Systems Laboratory). D.O.T. has opted to build instead a 2¾-hour system, at more modest expense, and to continue it down to Washington. The Northeast Corridor will get, if all goes well, some $1 billion in rail transportation study and construction.

The plans have the fullest support of the New England Governors, who have been discussing a rail proposal for months and vowed in mid-September to work strenuously for such a commitment from D.O.T. Their independent accord, says Richard Bowen, Acting Director of the Governors' New England Rail Passenger Office, ought to be of considerable help when Congress attends to the request. (The 12 states affected by the rail line send 24 senators and 127 representatives to Congress.) Mr. Bowen feels two other benefits will accrue—and invigorate the fight for the money: the secondary advantages of trains over aircraft, and the jobs from $460 million in public works.

The New England Governors' rail proposal was essentially the same as D.O.T.'s: to improve the existing (or shore) line at a cost of $200 to $300 million by the mid-1970's. But another proposal given them, by the Geo-Transport Foundation of New England (with assistance from M.I.T.'s Urban Systems Laboratory), documents the utility of a slightly different high-speed rail line. Geo-Transport proposed a new direct line between New Haven and Providence (for $466 million) which would, with improvements to the segments on either side (*see map*) permit a two-hour trip (at a total cost of $690 million). A two-hour trip, these studies showed, would draw 4.4 million riders by 1979 (the target year); a three-hour trip, 2.45 million by 1975. Presently, the annual rail haul is about 700,000.

Geo-Transport said that its two-hour train would break even from revenues on its operating costs the first year it ran; D.O.T. feels a three-hour train ought also to be economically justifiable. From the whole Washington-Boston corridor, D.O.T. expects to gather some 20 million riders by 1980. Attracting passengers from airplanes would cut the need for expanding Boston or New York airports or for building new ones—they cost perhaps $2 billion apiece—which adds considerable leverage to the rail proposals.

By 1975 or so, D.O.T. hopes to have information from its research studies to decide on a system for the 1980's, and the one to be improved now will then be fitted into the final plans. D.O.T. hopes the funding can be authorized in this fiscal year, and three years are then needed to finish the work.

To Put the Pilot In the Picture

In the crowded airspace around a major airport, today's commercial pilot plays a somewhat pawn-like role. Even in the clearest weather, he flies under the "instrument flight rules" that were originally designed for conditions of bad visibility, for at modern speeds and traffic densities he can avoid collisions only by doing exactly what he is told by the controller, who—unlike the pilot—can see the overall traffic picture.

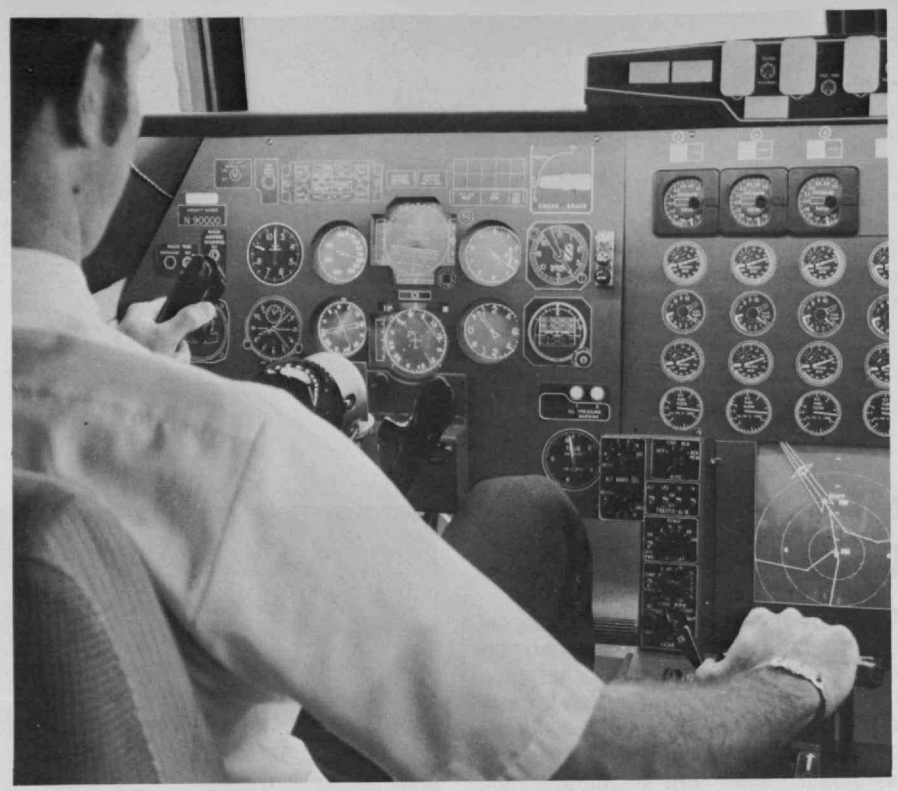
The pilot obtains some idea of what is going on around him by listening to the conversations between the controllers and the other pilots. Under current Department of Transportation plans, he may lose even this source of information. The voice channels are becoming overcrowded, and the solution proposed is to give each aircraft its own "discrete-address" data-link, which will supply the pilot with his individual orders and nothing else.

Understandably, this loss of information derived from party-line communications causes some concern among pilots. However, they have been cheered by a possibility that is being studied by a consortium of M.I.T. laboratories—the Electronic Systems Laboratory, the Flight Transportation Laboratory, and the Man-Vehicle Laboratory. The idea—which does not conflict with present trends in air traffic control—is to use the discrete-address data-link to transmit to the aircraft portions of the information that the controller sees on his radar screen. This information would be displayed on a small cathode-ray tube in the cockpit—how much, being at the discretion of the pilot.

At present, an experimental on-board display system is set up in a simulated 707 cockpit (*see photographs*). The essential conventional instruments are also displayed, using a second CRT. Aircraft movements and instrument data are calculated in real time by an Adage AGT-30 digital computer, in an adjacent room. The study team, led by Mark E. Connelly, Professor Robert Simpson and Professor Renwick Curry, is currently investigating the effects of variations in the kind of data displayed, using experienced airline, military and commercial pilots as test subjects.

The major U.S. airports are currently being equipped with an improved display system known as ARTS-3. In this partly automated system, each radar blip representing an aircraft is accompanied by an electronically written "label," showing pertinent information such as the identity, altitude, and speed. Essential map information (approach and landing routing) is also indicated.

In the M.I.T. scheme, the picture is converted to the pilot's own frame of reference. At his discretion, the map can be scaled up or down, and only those aircraft within a chosen range of altitudes are displayed. Besides acting as a "security blanket" for the pilot (in deference to the philosopher Schulz, who has much influence in the aerospace world, the system is called Linus) such an on-board display could simplify the work of the traffic controller. For example, it would be possible merely to tell the pilot to follow a specified aircraft at a distance of four miles, rather than having to spell out in a series of heading and speed commands the detailed means of achieving such a spacing. Greater precision in spacing should be possible, and this in turn can be translated into greater runway capacities and higher levels of safety.



The instrumentation of this Boeing 707 cockpit is unconventional in one respect: the screen near the pilot's right hand displays an extract from the information available to the traffic controller on the ground. The idea is to give the pilot a working knowledge of his situation with respect to other aircraft, rather than having to take the traffic controller's detailed instructions on trust. (Of the other instruments in the picture, most are static photographs; a group of six active instruments—those which are essential for a realistic "flight"—are simulated by a single C.R.T. screen, partly covered by the panel directly in front of the pilot.)

No Vehicle in the Millenium?

"Even if you deliberately set out to do so, you could hardly have conceived a more ridiculous design for an urban transit vehicle than today's automobile."

Two Canadians—C. Beaumont Lewis, Director of Planning and Development for the Canadian Transportation Development Agency, and John Gatwick, his boss as Director of the Agency, said essentially the same thing in two separate sessions of the Symposium on Motor Vehicles and the Urban Environment at the University of Toronto this summer.

Their reasons were also more or less identical:

☐ The automobile provides about 120 b.h.p. per passenger, about the amount used by a subsonic aircraft in take-off. This is 15 times more than is needed for an urban vehicle, said Mr. Lewis.

☐ Every automobile requires some 300 sq. ft. for conventional off-street parking. Since average occupancy in city use is about 1.5 persons, Mr. Lewis noted, the office worker uses twice as much urban space for his car as for his

office.

☐ The automobile is too wide. "The ultimate in narrow vehicles is the bicycle," said Mr. Gatwick—sometimes not as wide as its rider. Vehicles are now so wide that a stalled one requires essentially infinite space—it closes the entire lane in which it sits.

☐ The automobile should be "touchable," so that "moderate contact between vehicles" could take place without damage, suggested Mr. Gatwick. (But he admitted that the present "fragile finish and styling are linked to the individual's identification with his automobile," and to achieve "touchable" vehicles will require "more than design."

☐ What about automated control? Not really, said Mr. Gatwick. "For a 10-pound instrument with some 10 billion logic circuits, power consumption of 15 watts, and manufactured by unskilled labor, the human brain has a fair amount of available computing power, very adaptive programming, and an incredible capability to use error-ridden, noisy and largely redundant input data." But some improvements here, too: "primary data acquisition by the operator is by sight," so try to improve visibility; bring communication between vehicles (by sound, light, "and the occasional leer") out of its present "rudimentary" stage. Improve secondary sources of information such as the traffic helicopter.

☐ Improve vehicle utilization. "No business could stay in business if it invested in machinery which stood idle some 97 per cent of the time," said Mr. Lewis. Indeed, he said, if vehicle utilization could be increased to 6 per cent—or if occupancy could be increased from 1.5 to 3—cities would have only half the number of cars and need only half the parking spaces.

Though these utopias still escape us, both speakers found eager listeners in their audience—members of the student design teams from 40 American and Canadian universities who are beginning work on their "ideal" urban vehicles, to be entered in next summer's Urban Vehicle Design Competition. They were less worried than their elders about the "wave of nostalgia" which Mr. Gatwick suggested prevents the radical rethinking we need about urban transportation. For example, we consider buildings as located on streets; but perhaps we should think of streets as located between buildings.

And Mr. Lewis speculated that a form of "Parkinson's Law" will persist: "The automobile population will forever expand to fill the pavement area available to it." His conclusion: we must plan "systems of restraint," and we must prepare for them by seeking a quantitative definition of "efficient" in the context of urban transportation.

"How do you measure power?" asked one of General Motors' speakers at the symposium on "Motor Vehicles and the Urban Environment" at the University of Toronto this summer. "In volts and amps," answered the student, who was extolling the efficiency of the electric propulsion planned for his team's entry in the Urban Vehicle Design Competition.

"That's not good enough," said the engineer who had worked on the design of G.M.'s three prototype urban vehicles in 1969. The vehicles, displayed at the Toronto meeting, attracted ample attention from students who sensed that they largely fulfilled the design goals set for their own entries in U.V.D.C. (Photo: Joseph L. Kashi, '72)

Urban Vehicles: How Radical the Future?

Even today's engineering students, called on to design the personal urban transportation of the future, seem to admit that it may not be so different from today's multipurpose automobile after all. Does this mean that engineering students are more down to earth than you thought? Or is it simply their recognition of a fact of life—that the backlog of conventional expertise and parts for internal combustion engines is just too powerful to buck?

By the time of its late-summer symposium at the University of Toronto (*see above*), the Coordinating Committee for the 1972 Urban Design Competition had received design proposals for 43 cars to be built during the current academic year by student-faculty teams at 38 U.S. and Canadian engineering schools. More than half are for cars powered by conventional internal-combustion engines with pollution-control accessories; 17 specify natural gas or propane as fuel, nine unleaded gasoline. All will be small cars, for the contest rules encourage low emission standards, low noise, small overall size, passenger safety, and low collision-damage potential.

But not every car planned for next summer's U.V.D.C. tests is so conventional. Andre Houle and Michael Keller, students in the University of Maryland Chemical Engineering Department, came to Toronto with a plan for a conventional electric car powered through a zinc-air battery. Terrence T. Cafferty, of the University of Nevada Mechanical Engineering Department, described a paper-honeycomb-and-fiberglass car to be powered with a vapor-cycle engine using liquid nitrogen, devised by Professor Lindley Manning, the team's faculty adviser. And Dean Athans of the University of Southern California said his team will be making use of a "superflywheel energy storage device" comprising "twin counter-rotating flywheels 'rechargeable' by either an on-board electric motor for quick 'rev-up' charges or an external high-powered motor for overnight use." The flywheels will drive an alternator which will power individual motors at each wheel.

Joseph Finegold of the University of California (Los Angeles) said his team's objective will be "to prove the feasibility of a no-pollution internal-combustion-powered vehicle that would use a limitless and inexpensive fuel"—a magnesium-hydride alloy which would release hydrogen to be combusted in the chambers. He reported that his student team, working with Professor A. F. Bush as faculty adviser, has "tested a preliminary power plant and has discovered techniques to prevent the formation of nitrogen oxides and ammonia."

The preliminary presentations at To-

ronto also included five cars powered by Wankel internal combustion engines, six electric-hybrid cars carrying both electric motors and internal combustion engines, eight steam- or vapor-powered cars, and three all-electric vehicles.

Will all these cars—exotic or conventional—really work? Will two—or even one—become the prototypes for the urban vehicle for the 21st century? Probably not. But, says Robert Michaud, an M.I.T. graduate student in mechanical engineering who is Chairman of the U.V.D.C. Coordinating Committee, that is really not the point. "U.V.D.C.," he says, "is foremost an educational endeavor seeking to complement traditional forms of engineering education, by offering students a chance to gain practical engineering skill while working on a socially important technical problem." Industrial participation will be limited; the students cannot use professionally designed vehicles or even subsystems—such as pollution-control systems—without risking heavy penalties on the judges' score cards.

The scoring will be done in August, 1972, when teams bring their cars first to regional competitions and then to a national meet. There will be performance tests under urban driving conditions, and the vehicles will be judged on emission control, passenger safety, collision-damage resistance, noise, handling characteristics, and probable manufacturing cost.

...And How To Pay?

Students conducting the Urban Vehicle Design Competition (*see above*) and those building cars to compete in it share many technical problems and one fundamental non-automotive problem: money. The U.V.D.C. Coordinating Committee now estimates that the whole effort—which is as much an experiment in engineering education as in automotive design—may cost nearly $1 million.

The Committee says each team—43 are now actively at work—will need about $20,000 in cash and parts to build and test a vehicle. And the Coordinating Committee itself will need considerable financing to stage the preliminary and final competitions. Where will it come from?

The Canadian Transportation Development Agency has stated that it will fully support all six Canadian U.V.D.C. entries, to a total of perhaps $120,000. Several U.S. agencies, including the Department of Transportation, Environmental Protection Agency, and National Science Foundation, have indicated interest. The teams now at work on entries have been promised about $200,000 from their respective schools. But the funding gap is still big—and worrisome, according to Joseph L. Kashi of the U.V.D.C. Committee.

These cost figures are of a totally different order of magnitude from those required for the 1970 Clean Air Car Race. This is because last year's cars were generally built by making modifications to existing vehicles. But there are no urban vehicle prototypes; U.V.D.C. entries, Mr. Kashi says, will have to be built as "complete systems, new from the ground up."

URBAN

Anti-Growth Policy Foiled by Civil War

"Of the many policies examined that are commonly assumed to help an urban area, construction of low-cost housing appears the most detrimental," wrote Professor Jay Forrester in his article "A Deeper Knowledge of Social Systems" (Technology Review *for April, 1969, pp. 21-31*). If the area is to revive economically, it is essential that the excess housing at the lowest level be removed. Otherwise anything that tends to improve living conditions will attract enough lowest-income people into the available housing to pull the standard of living back down. . . ."

During the sixteenth century, the population of London increased from about 50,000 to a quarter million. "Queen Elizabeth I issued the first proclamation in restraint of new building in London and three miles beyond its gates on July 7, 1580. It was a blanket prohibition against all new building and the dividing of tenements," writes Thomas G. Barnes, Professor of History at the University of California, Berkeley, in Vol. I, No. 1 of the *Ecology Law Quarterly*. The intent of this and many subsequent royal proclamations was apparently to prevent the newcomers from becoming overcrowded—either in new buildings on what had been open space, or in existing buildings that had been subdivided or extended for greater density.

The low-cost housing business thrived almost unrestrained, nonetheless, until 1590, when a special housing commission began to prosecute offenders. Even then, writes Professor Barnes, "despite the apparent blanket prohibition of new building by the first proclamation, in fact the commissioners had early recognized that building was going on and that their task was to slow it down, particularly by pressure to build only on old foundations, and to prevent the worst excesses of dividing tenements and converting sheds and the like to dwellings. This was . . . the governing policy of the commissioners until the early 1630's."

The Elizabethan regime was not entirely a heartless dictatorship. A "remarkably thoroughgoing" welfare system was established around the turn of the century, nationally legislated but supported by local taxes—which provided another reason for trying to prevent London from acquiring more than its fair share of unemployed.

The first entry in the 1972 Urban Vehicle Design Conference may already be running: this a.c.-electric-powered car unveiled at the University of Toronto symposium on Motor Vehicles and the Urban Environment. Among its admirers—in addition to builders, three University of Toronto engineering faculty who have joined to form Vehicle Research, Ltd., and to employ several Toronto students—is John Gratwick, Director of the Canadian Transportation Development Agency, who was the symposium keynoter.

Under the next two monarchs, James I and Charles I, the anti-building proclamations were refined until they incorporated some quite detailed quality codes, revealing the guiding influence of the great architect Inigo Jones (Surveyor-General of Works under both kings). But the business of prosecuting and fining offenders, Professor Barnes tells, degenerated into a means of raising revenue. Relations between monarch and parliament were becoming increasingly strained, until in 1629 the link was broken completely by Charles, who consequently found himself in financial difficulties. The prosecution of builders, as it happened, was a function that had been initiated by a monarch and remained in the hands of the king. The result was that when the civil war came, the anti-building measures were scrapped along with much else that was royal. In the 1640 parliament's list of grievances, "the restraint of the liberties of the subjects in their habitation, trades and other interest" was number 28. Those who petitioned parliament for the preservation of building control even included one of the anti-monarchists—a lawyer named William Pymne, who had been sentenced to life imprisonment by the king and rescued from it by parliament. But parliament had more pressing matters to deal with.

In economically depressed parts of U.S. cities, such as the area of Boston's South End shown here, there comes a time in the life of a dwelling when the rents obtainable from it do not justify the costs of repairs, services and taxes. The building is abandoned by its owner as worthless. The New York City-Rand Institute is trying out a rational method of evaluating the predicaments of individual "problem buildings", to discover in each case how to prevent the building from being abandoned, by a judicious use of limited public funds. (Photograph: Owen Franken)

70 Options for a Problem Building

A critical stage in the deterioration of an urban area is the process known as disinvestment (*see "Trend of Affairs" for July/August, 1971, pp. 45-46*), when landlords cease to invest in property in the area because income from rents no longer justifies the expenses of ownership and upkeep. The next and final stage is the abandonment of such property, in a state of serious disrepair.

What can be done to encourage landlords to re-invest and thus keep their property in use? There are many possibilities open to a city government, but they all cost money. Hitherto there has been little rational basis for strategy, and it is by no means obvious that the overall problem can be solved at all. But in New York City an experimental unit called the Problem Buildings Evaluation and Treatment System (P.B.E.T.S.) is trying out "a system for the clinical diagnosis and treatment of problem buildings," which predicts the effects of alternative forms of assistance in each particular case.

The term "problem building" is hard to define, but if it is taken to mean a building with more than 10 outstanding housing-code violations, it applies to more than 10 per cent of New York City's apartment buildings. More generally, from the city government's viewpoint, it is a building which gives rise to complaints by tenants, or on which the landlord has ceased to pay taxes. The measures that can be taken include the following: the owner may be helped (by subsidizing repairs, granting tax benefits for improvements, or—if there is rent control—allowing him to raise the rents); or he may be punished or dispossessed; or the city itself may repair or demolish.

The New York City-Rand Institute's C. Peter Rydell, listing these alternatives, comments that "they have not in fact been handled as alternatives . . . By and large, which of these responses the City makes has been simply a matter of the circumstances under which a building comes to the City's attention."

And the Rand Institute has devised what it calls the Landlord Reinvestment Model, "to enable estimation of the level of city assistance required to induce a landlord to reinvest in his property through performance of required repairs, payment of debts, and provision of adequate maintenance in the future." When the above list of strategies is refined to include, for example, alternative financing schemes, it turns out that there are 70 distinct options. The Landlord Reinvestment Model computes, for a given building, the outcomes of all of these which are at all feasible, so that a rational choice can be made, in line with the P.B.E.T.S. policy objective of bringing as many buildings as possible up to housing code standards with the limited financial resources available.

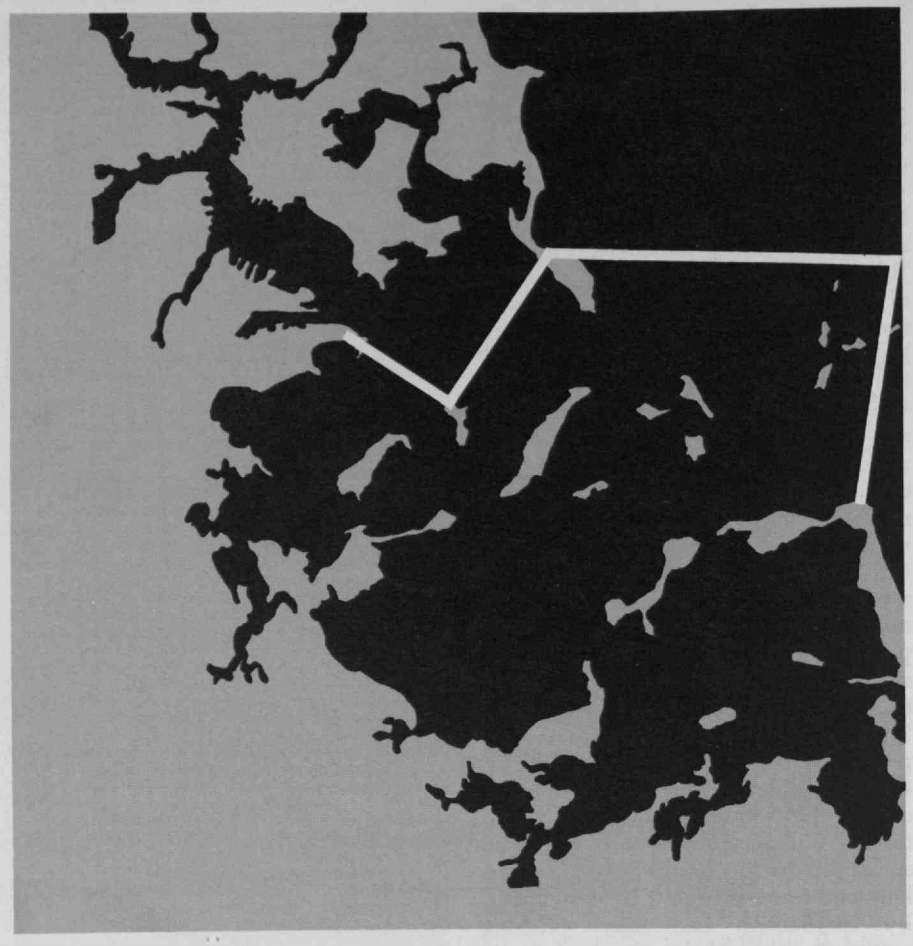
At first sight the task of multiple economic predictions would seem to be one for a computer, and thus it was originally conceived and performed late in 1969 and early in 1970. At present, however, a smaller set of alternatives is being used, and the calculations are being done manually. Even so, P.B.E.T.S. is currently evaluating buildings at a rate of about 1,000 a year, according to Mr. Rydell, who rates this as an "experimental or pilot project" scale of operations.

From Exploit to Save

Rejecting several M.I.T.-based studies for the development of Boston harbor for residential, industrial, transportation, and recreational use, the Massachusetts legislature in 1970 gave the state's Department of Natural Resources broad—but not broad enough—authority to acquire and operate this unique natural resource for recreation and conservation, and not for intensive recreation-residential use. Now two M.I.T. graduate students have taken another look, resulting in some new recommendations—consistent with the legislature's action and therefore inconsistent with previous M.I.T. plans—for the Department of Natural Resources (D.N.R.) and for the Metropolitan Area Planning Council, which has contracted with D.N.R. for a comprehensive plan for harbor use due in the spring of 1972.

In a paper prepared for Michael S. Baram, Associate Professor of Civil Engineering, this spring, Anthony C. Picardi and William Blatchley urge formation of a Boston Harbor Section within D.N.R.'s Division of Forests and Parks; the new section then should:

1. Press for the addition of 5 sq. mi. of Boston Harbor surrounding Logan Airport which is "arbitrarily" excluded from the 1970 act. Failure to include this area, which presumably remains under jurisdiction of the Corps of Engineers and the Massachusetts Port Authority as operators of Logan Airport, "is a blatant disregard for the public use" of much of the Inner and Winthrop Harbor areas.
2. Organize public education about conservation. Only private groups are now engaged in such programs, and "the crux of the problem lies in the tendency for the human appreciation of open land values to decrease . . . People tend to be unaware of the lost opportunities resulting from each incremental development of open space."
3. Develop an advisory committee "embodying the long-term interests of public physical and mental health, and the often 'intangible' esthetic interests."
4. Encourage enforcement of existing legislation dealing with shoreline dredging, filling, and conservation.
5. Develop a plan for public access to the shoreline, an issue which is at present in the hands of each town government (since title to beaches in Massachusetts was granted to seashore landowners in the 1600's).
6. Survey the Harbor resources and "exploit in full" the control activities granted to D.N.P. in the 1970 act.



The Massachusetts legislature drew a peculiar map when it defined the limits of Boston Harbor to give the Department of Natural Resources control of all its land for recreation and conservation. Areas south and west of the heavy line were included; but areas north of it—notably the lands adjacent to Logan International Airport, under jurisdiction of the politically powerful Massachusetts Port Authority, were excluded; this area remains protected only by the Corps of Engineers. Studying the issues last year, two M.I.T. graduate students concluded that the legislature's action was a "blatant disregard for the public use" of at least 5 sq. mi. which by no geographical standard (but only a political one) can be considered outside Boston Harbor.

INSTITUTIONS

"Make Me a Report"

The National Science Foundation—whose budget for fiscal 1972 is likely to be about $600 million—may have begun in this casual conversation between Franklin D. Roosevelt and Vannevar Bush:

"What's going to happen to research in scientific subjects in this country when the war is over?" President Roosevelt one day asked Dr. Bush, who was then Director of the Office of Scientific Research and Development.

"As far as I can see now, Mr. President, it's going to fall flat on its face."

"Well, you'd better make me a report on it."

This was the beginning of the landmark report on *Science, the Endless Frontier,* submitted to President Harry S. Truman by Dr. Bush in 1945. It was typical: "An awful lot of things Roosevelt took up with me were handled in an extraordinarily offhand way."

This anecdote is recorded in *Mosaic,* the National Science Foundation's magazine, reporting a visit to Dr. Bush by William D. McElroy, who was at the time of the visit Director of N.S.F. and has since become Chancellor of the University of California (San Diego).

Dr. Bush's report on *Science, the Endless Frontier* is widely credited with containing the origins of the National Science Foundation, though Dr. Bush makes no such claim for the report. N.S.F. was almost inevitable, Dr. Bush told Dr. McElroy: "The origins of the Foundation lay in the fact that this country became alert during World War II to the power of government-supported research, and then some form of organization for the purpose was inevitable."

Today's N.S.F. is far bigger than Dr. Bush—or presumably anyone else—foresaw in the 1940's. Is it doing a good job? Yes; "the results have been

better than I expected," Dr. Bush said.

"The great danger from the beginning was that the support would be for applied research entirely, and that basic research would be left out. . . . The fact that N.S.F. emerged with an orientation toward basic research was a very fortunate thing."

What of science and technology in the next 20 years? "I never try to answer that question," said Dr. Bush. "I sometimes say that I think that someday we'll get back to where we can make a good five-cent cigar."

Seriously, he said, he foresees "the greatest advances" coming in the field of biology. Dr. McElroy, himself a biologist, agreed: "I always like to think that we're going into a biological revolution," he said.

Organized Confusion?

Though it cannot be tolerated in a conventional research organization, "management ambiguity" may be the key to success in multidisciplinary research. And don't expect the traditional sequence of events, either: the technological advances leading to multidisciplinary success almost always are achieved at some informal level, before developments seem to justify a formal research arrangement.

The key to successful interdisciplinary research, says Donald G. Marquis, Professor of Management at M.I.T., is to devise a pattern of support which yields a new technology before anyone connected with the effort realizes what is happening. Professor Marquis, summarizing for alumni the studies of multidisciplinary projects conducted by his group in M.I.T.'s Sloan School of Management, at a seminar on engineering applications to medicine this spring, listed four guidelines to help make multidisciplinary research projects work well:

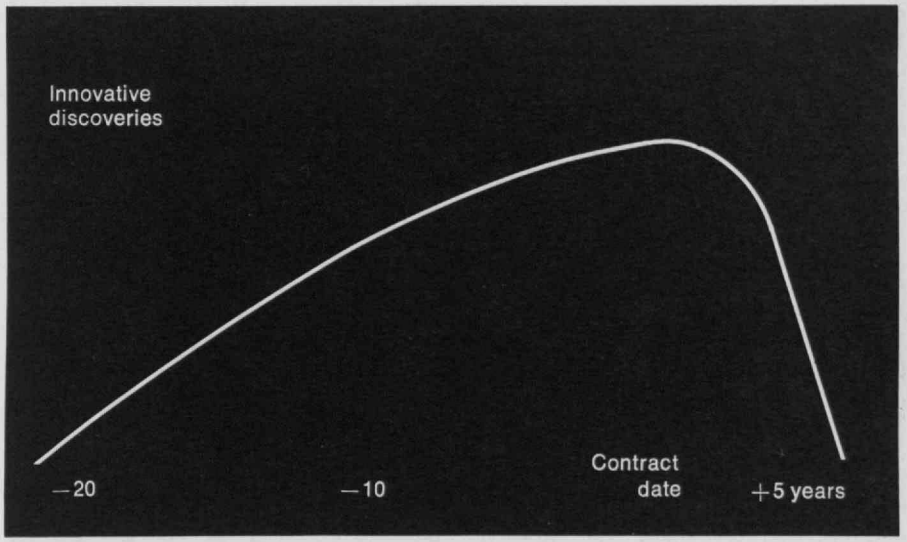
☐ Be sure to define the need for and the function of the system which the multidisciplinary work is to yield.

☐ Designate as project manager a generalist who has no stake in any one of the disciplines involved. The "neutrality" of the project manager—in contrast to the specialists working in each discipline—is the single characteristic which distinguished successful management in all the projects studied by Professor Marquis and his colleagues.

☐ Consider forming an "independent" institution with which all interdisciplinary participants can identify. This is especially important if two widely disparate institutions or disciplines—such as engineering and medicine—are involved.

☐ Appoint a specialist in charge of

Visiting with William D. McElroy (left), then Director of the National Science Foundation, Vannevar Bush—who was in charge of the Office of Scientific Research and Development in World War II—recalled he "was scared stiff" when he first appeared before a congressional committee. Later he "got so I didn't mind it" and finally "so that I enjoyed it. There was just enough risk in it to give it zest." Politics, Dr. Bush said, "is the most important profession that we have," and most scientists get in trouble because they think of it as "second-rate. . . . If you respect the men in Congress who are pretty well toward the top in politics, and it's genuine and they know it, you can meet with them on a basis where there is no trouble at all." (Photo: N.S.F.)



After studying a large number of interdisciplinary research projects, Donald G. Marquis, Professor of Management in M.I.T.'s Sloan School, concludes that most of the technological advances essential to success precede the project itself. Less than 40 per cent of the new concepts incorporated into an interdisciplinary result came later than the prime contract date, according to his research.

that part of the multidisciplinary project which is his specialty. This will mean that most project researchers are in fact reporting to two people—the generalist project manager and the specialist team leader—a situation which seems to violate one of the first principles of research management.

How to divide authority between disciplinary leaders and project manager? There is no good answer, nor need there be: there must be some ambiguity, and Professor Marquis' studies reveal no correlation between ambiguity and project success (or lack of it).

NUCLEAR

Breeder Reactors: Some Doubts

President Nixon, the Atomic Energy Commission, various power-generation equipment manufacturers, and some very prestigious nuclear engineers are in substantial agreement: the development of liquid-metal-cooled breeder reactors must be given top priority among possible energy sources. The best publicized opposition has come from the Scientists' Institute for Public Information, which holds that, under the National Environmental Policy Act, recent A.E.C. funding requests for the breeder program should have been accompanied by a statement on the environmental impact of such reactors as a type. The A.E.C. replies that impact statements will be supplied for individual reactors, and in July the Agency provided a draft environment statement on a proposed demonstration breeder. S.I.P.I. considers that a switch from conventional reactors to breeders is a sufficiently radical technical change to deserve environmental evaluation as a whole, before development goes any further. But S.I.P.I. is not the only critic of the U.S. breeder program.

The basic concept of "breeding" is the conversion of material which is not useful as reactor fuel into material which is, the conversion being induced by excess neutrons from a fission reactor. These excess neutrons are those which are not required to keep the fission chain reaction going at its constant rate. In all present-day nuclear power reactors, the great majority of the neutrons are slowed down (moderated) before they are reabsorbed in the fuel material.

Some of the excess neutrons are absorbed uselessly during this slowing down; so it appears that, to achieve the stringent neutron economy required for breeding, a breeder reactor must operate with neutrons near their original high energy. This entails the use of a physically smaller, higher power-density core, and also requires that the cooling materials be chosen from those heavier elements that do not cause excessive neutron moderation.

The specific breeding process which the A.E.C. is considering is the conversion of the hitherto useless and plentiful uranium isotope U-238 into fissile plutonium (although other reactions, such as the conversion of thorium-232 into fissile U-233, have also been proposed). Given this concept, the reactor designer is faced with a number of choices: the operating temperature range; the coolant fluid; the structural materials; the chemical and physical form of the fuel elements. The A.E.C. seems now to be committed to liquid sodium as a coolant, and fuel elements clad in stainless steel.

This combination immediately raises an interesting technical difficulty. Stainless steel, bombarded with fast neutrons, becomes swollen and distorted (*see "Trend of Affairs" for July/August, p. 56*). Below a certain temperature, this does not happen so rapidly, but lower temperatures mean lower thermodynamic efficiency. The swelling also diminishes if, instead, one goes to very high temperatures—whereupon, however, the sodium and the steel begin to react chemically. Another way out would be to modify or replace the steel so that swelling does not happen—which is the subject of much current research, all of which has to bear in mind the question of chemical reactions with the coolant. If the swelling problem remains unsolved, the implication is that fuel elements will have to be replaced more frequently than in a conventional reactor—which could have profound effect on the economics of breeding.

This gives an indication of the kind of technical problems which arise in breeder design. Lawrence M. Lidsky, Associate Professor of Nuclear Engineering at M.I.T., puts it this way: a breeder reactor must satisfy three criteria—it must be safe, it must be economically worthwhile, and it must "breed." The technological considerations are such that these desiderata must be played one against the other. Although it is relatively easy to design reactors that can meet any desired two of these three criteria, Professor Lidsky knows of no currently proposed design that can simultaneously meet all three.

The range of alternative design strategies is wider than has been indicated above. Some European breeder programs, for example, favor gas cooling instead of liquid metal. But A.E.C. researchers have been hampered by funding limitations from investigating the full range of design concepts. There seems to have been no effective reassessment of the basic alternatives during the past three years. Professor Lidsky is among those who believe that A.E.C. has concentrated its attention prematurely on a technology which may not be the best available—if indeed an engineering solution to the three-part breeder design problem is to be found at all.

A Chemico-Nuclear Power Reactor

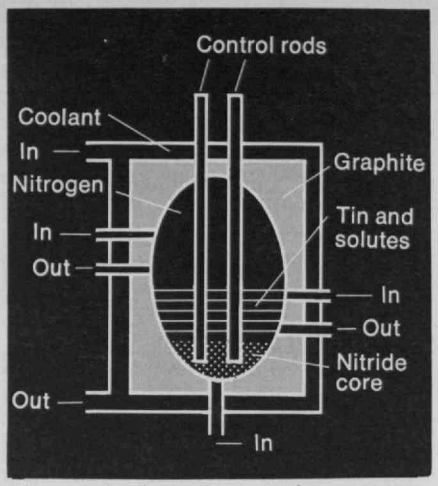
One of the differences between nuclear and fossil fuel is that every nuclear fuel element must be accurately machined before use, and must be subjected to a complex chemical treatment afterwards, before more than a few per cent of its fission-energy content has been extracted. Coal, oil, and gas make no such demands.

Could the core of a nuclear reactor ever be made as simple as a coal furnace—fuel in, "ash" out? It appears that it could, according to Robert N. Anderson and Norman A. D. Parlee, of Stanford University's department of mineral engineering and the Parlee-Anderson Corporation, Burlingame, Calif. The key is to operate in a vat of molten tin under an atmosphere of nitrogen.

At temperatures in the range 1500-1800°C., and with a nitrogen pressure of around one atmosphere, the chemistry of this situation is as follows: Nitrogen is in solution in the tin. Uranium dissolved in the tin is mostly precipitated as the nitride, UN, which is denser than the liquid uranium-tin alloy and sinks. When the amount of uranium nitride reaches a critical mass, a fission reaction begins. Any resulting temperature rise tends to cause some of uranium nitride to dissociate, putting uranium back into solution. This equilibrium provides the nitride "core" with the necessary stability against temperature changes. Nitrogen pressure is a control variable.

Fission products (including the neutron-absorbing "poisons" which befoul conventional reactors) behave in one of three ways. Either they bubble up through the tin and enter the nitrogen atmosphere; or they dissolve in the tin; or—in a few cases, and only at high concentrations—they form lightweight nitrides, which float to the tin surface. Both the molten tin and the nitrogen are cycled through fission-product removal processes. The tubing for the tin circuit, in the designers' conception, would be of graphite.

As uranium is converted into fission products, the nitrogen/nitride equilibrium causes more uranium to precipitate as nitride, replenishing the "core." According to Anderson and Parlee, the system behaves in the same way with



This novel scheme for a nuclear reactor grew out of a study of a new technique for reprocessing nuclear fuels. R. N. Anderson and N.A.D. Parlee found that fuels and fission products behave in a very convenient fashion in liquid tin containing dissolved nitrogen.

other nuclear fuels, and could even be used as a breeder reactor, converting nonfissile isotopes to fissile ones and using them on the spot. "All actinides," says Anderson, "including those formed by neutron capture and decay, will behave in the same manner, dependent only on their chemical activity in solution. Therefore, a mixture of thorium" (a breeder fuel) "and uranium would produce a mixed nitride in the core—the proportions being related to their concentrations in solution. The mixture of nitrides will breed nicely, especially so since we have no requirements for internal structure to disturb our neutrons."

The proposed reactor is conventional in two respects. It has control rods, to provide rapid-action control during fuel additions, and it has a coolant circuit surrounding the tin-tank (a certain amount of heat could be removed from the tin circuit, but not enough for commercial power generation). At present the molten-tin reactor is only a concept, based on laboratory studies of the underlying chemistry.

Water Reactors Without the Water

Four members of the Union of Concerned Scientists (U.C.S.) have this summer drawn attention to what they believe is a serious risk inherent in the design of U.S. water-cooled nuclear reactors (the conventional nuclear power source in the U.S.). In a 30-page report (an edited version will be published in the American Nuclear Society's *Nuclear News*) they propose that if one of these present-day reactors were deprived of the water in its primary coolant circuits, the outcome could easily be catastrophic: they envision that if the emergency cooling system failed to perform its designated task, the reactor core, uncooled, would melt its way through its containment into the earth below, releasing enough fission products for lethal effects to extend, under the worst circumstances 75 miles downwind.

Whether or not an emergency core-cooling system works depends upon whether an effective coolant reaches the fuel elements quickly—and so dissipates the heat of radioactivity. In the time between the loss of the primary coolant and the arrival of some substitute, the temperature of the fuel elements is rising due to the decay of fission products. The problem is to halt this increase in temperature before the fuel elements deform or melt.

The U.C.S. group consists of Henry W. Kendall (Professor of Physics at M.I.T.), Ian A. Forbes (a nuclear engineer on the faculty of the Lowell Institute of Technology and a part-time researcher at M.I.T.), James J. Mackenzie (a nuclear physicist with the Massachusetts Audubon Society and a visiting lecturer at M.I.T.), and Harvard economist Daniel F. Ford. The group states that it is in favor of nuclear power generation, provided there are proven safety systems capable of preventing a core meltdown following a loss-of-coolant accident. Their report is based entirely on Atomic Energy Commission publications and A.E.C.-sponsored work—in particular, on a semiscale test of the principles used in current emergency-core-cooling systems during the initial phases of a loss-of-coolant accident. These tests were carried out between November, 1970 and March, 1971, by the Idaho Nuclear Corporation under contract with the A.E.C.

In the tests, a major primary-coolant leakage was simulated on a simplified one-tenth-scale model. The emergency water supply entered the reactor vessel as intended but immediately escaped through the primary-coolant leak without having any measurable cooling effect on the simulated "fuel rods." The U.C.S. group judges that "the results of the Idaho tests clearly demonstrate the basic inability of current pressurized-water reactor emergency core-cooling systems to perform the functions for which they were designed." The group believes that the delay in cooling the core introduced by having all the initial cooling water ejected may be too great to be overcome by subsequent core flooding.

Simulating an Accident

What the Idaho results in fact demonstrate is a moot point. According to G. O. Bright of the National Reactor Testing Station, who had overall responsibility for the tests, they were intended "to investigate the hydraulic, thermodynamic, and mechanical behavior of a pressurized-water system during a loss-of-coolant accident" (*reference below*). Looking at it another way, the aim was to test the computer-simulation programs which are used in the evaluation of real emergency coolant systems.

Some of these computer programs are proprietary. It appears that Idaho Nuclear's programs failed to predict the behavior of the model; but it is claimed that programs used by other companies (in particular, Combustion Engineering) would have succeeded—and that, therefore, when these programs are used on a real design, and predict satisfactory performance they are to be believed.

"But Nothing Has Happened"

Be that as it may, the A.E.C. responded to the Idaho observations by setting up a Task Force to assess their significance, and then (in June, 1971) by issuing an "interim" set of acceptability criteria for emergency core-cooling systems. These criteria were published in the *Federal Register* on June 29, thus beginning a 60-day period during which interested parties could submit their comments.

This was unusually quick work. It was explained that, in view of health and safety implications, "the Commission has found that the interim acceptance criteria . . . should be promulgated without delay (and) that notice of proposal issuance and public procedure thereon are impractical. . . ." An A.E.C. press release dated May 27 stated that the results of the Task Force review on emergency cooling systems "should be available in a few weeks." This report would have been useful to those wishing to comment on the new criteria, but in fact it did not emerge during the 60-day period.

The U.C.S. group, with even less formality, sent their own report out for comment to the recognized experts on reactor safety systems. By late August, when they were putting the finishing touches to a second report (which served as their response to the A.E.C. interim criteria), they had received no replies. As one of the group put it, "we've been waiting for some response, but absolutely nothing has happened."

Norman C. Rasmussen, Professor of Nuclear Engineering at M.I.T., at this writing was preparing a report on emergency core-cooling systems, and he seems likely to conclude that these systems are extremely conservatively designed and that testing of them, subsystem by subsystem, has been adequate to ensure safety if primary

coolant is lost—the eventuality proposed by the U.C.S. group. Professor Rasmussen, who is critical of the U.C.S. group for failing to consult M.I.T. nuclear engineers (they reply that they consulted people currently doing research in the field), regards as "not warranted by the facts" the U.C.S. recommendation of "a total halt to the issuance of operating licences for nuclear power reactors presently under construction, until safeguards of assured performance can be provided."

A power reactor is a complex device, and there is seemingly no end to the contingencies that merit examination. The U.C.S. contention is that the particular contingency of a loss of primary coolant should have been examined experimentally long ago, and was not. Even before the Idaho test—which was only the first of a series—the A.E.C.'s Division of Reactor Safety had drawn attention to "all the factors affecting the performance and reliability of emergency core-cooling systems" as being "the most urgent problem in the safety program today" (*Water-Reactor Safety Program Plan,* February 1970, A.E.C. report WASH-1146).

That research into the safety of specific nuclear reactor systems goes on long after those systems have been put to work for the public is no secret. A good brief guide to the current state of water-reactor safety research is the above-quoted paper by Mr. Bright in A.E.C.'s *Nuclear Safety* for September/October, 1971, pp. 433-438.

The June interim criteria for an emergency core-cooling system specify that the system must not allow the fuel elements to rise above 2300° F. On the basis of recent experiments with real fuel rods at Oak Ridge National Laboratory, the four members of the Union of Concerned Scientists reply that many of the fuel rods would bow, swell and rupture at temperatures below 1800° F., and this could prevent entry of the emergency coolant to some areas of the core. This would not only imply a gross inadequacy in the A.E.C. interim criteria; it would also cast considerable doubt on the usefulness of the computer simulation programs which are used, with the criteria, to decide whether a given emergency system is acceptable. The programs assume that the geometry of the core does not change during the emergency, and it now appears that changes would occur well below 2300° F.

It is A.E.C. tradition that technical discussions of this kind are conducted under the aegis of the Commission. The U.C.S. team recommends—as so many other teams and individuals have done in various nuclear contexts—"a thorough technical and engineering review, by a qualified, independent group. . . ."

EXPLORATION

Eight Feet into The Moon

To arrive at even preliminary scientific opinions on the rock samples brought back by the remarkably successful Apollo 15 expedition will take until mid-October, but initial reports of high excitement among lunar seismologists were no mere publicity stunt. The sample-study group at Houston, led by Robin Brett (Chief of the Manned Spaceflight Center's Geochemistry Branch), is excited over three things:

First, the so-called genesis rock, which although seemingly not a specimen of the moon's earliest solid crust, is certainly the oldest rock yet retrieved.

Second, the eight-foot long core which David Scott drilled from the floor of Mare Imbrium.

Third, the mountain topography, which demands some kind of geological analysis.

At the time of writing, a little can be said of, at any rate, the eight-foot core. Visually it is easy enough to count 24 distinct layers in it, of which three are clearly igneous, that is, volcanic material. It seems likely that closer examination will confirm a suspected repeating three-layer pattern: lava-flow, covered by debris from the eruption which produced that particular layer of lava, covered in turn by debris from meteoric impacts during the period up until the next eruption.

There has been speculation concerning how long the moon's period of repetitive volcanic activity lasted: whether it all happened in a short period soon after the surface solidified, or whether it lasted much longer. (Circling the moon in the Command Module, Al Worden noticed cinder cones which one geologist said "might be no older than 1.5 billion years." So an important task is to date the layers in the core sample.

This small-scale layering, and the large-scale layering which the Apollo 15 astronauts observed in the Hadley mountains, are a source of satisfaction to at least one group of M.I.T. scientists. In a paper presented at the Second Lunar Science Conference in January this year (of which the proceedings are to be published shortly by M.I.T. Press) D. H. Chung, W. B. Westphal and Gene Simmons looked at the possibility of probing the moon to a depth of 150 km. with electromagnetic waves (in effect, radar, as opposed to the acoustic sounding used at present). They concluded that it was possible, but only at the remarkably low frequency of 4-7 kHz. They based their reasoning on laboratory electrical measurements of surface rocks from the Apollo 12 expedition, and on the assumption that, below the surface, the rock is horizontally stratified. And thus it proves to be. Whether NASA's engineers can devise a space-transportable radar that operates at this very low frequency is another question.

Certainly Chung, Simmons, and their colleagues have had some success in the past as lunar prognosticators. To the first Lunar Science Conference they contributed a study of the acoustics of the Apollo 11 samples, with predictions of sound velocities at depth, which has survived all subsequent sound-transmission experiments on the moon up to this writing.

PHYSICS

Tokamaks and Mirror Machines

The International Atomic Energy Agency's fourth triennial Conference on Plasma Physics and Controlled Fusion Research was convened (for the first time in the U.S.) at Madison, Wis., in June. There were few dramatic new results, but it was evident that considerable progress has been made since the 1968 meeting in Novosibirsk, U.S.S.R. It was that meeting which first spread the news of the Tokamak, the doughnut-shaped device that carried plasma research a major step closer to its goal of controlled nuclear fusion. For plasma physicists, the Tokamak has provided a much-needed sense of direction, and many of them are following this new trail.

Of the 40 theoretical papers presented, nearly half concerned themselves with toroidal systems like the Tokamak (the basic scheme of which was described in "Trend of Affairs," July/August 1969, p. 83). The particle orbits in toroids are very complicated, and the complication has a dramatic effect upon the physical processes of interest—particle diffusion and thermal conductivity (the aim, of course, being to reach higher densities and temperatures and maintain them longer). For example, under fusion conditions, the thermal conductivity in a torus exceeds that in a straight cylinder, by a factor which depends upon the thickness of the ring in relation to its overall diameter. One major accomplishment demonstrated at the Madison meeting was the complete working out of the theory appropriate to this so-called neoclassical regime.

A particularly interesting outgrowth of neoclassical theory is that the loss of particles by diffusion can be shown to lead to a toroidal electrical current in the plasma. This could be useful, because the initial heating of the plasma

is done by inducing just such a current, using an external magnetic field. It is conjectured that the new-found diffusion current could replace most of the original heating current (given a steady source of particles, a neutral beam for example, to make up the diffusion losses) and thus perhaps permit steady-state operation of Tokamak type devices. This self-generation of current leads to a fusion device called the "Bootstrap Tokamak."

The experimental results on Tokamaks have been similarly encouraging. The plasma density has been increased to nearly 10^{14} particles/cu.cm., ion temperatures to 0.6 keV, and confinement times to nearly 20 msec. (For comparison, thermonuclear ignition conditions call for energies of 4 or 5 keV, densities of 5 x 10^{14}/cu. cm., and confinement times of fractional seconds.)

Regarding mirror-type plasma containers—that is, open-ended magnetic bottles—developments are much less encouraging. It has long been known that open-ended plasma confinement devices had only a marginal chance of evolving into power production systems, because of the very rapid loss of particles from the ends. Dr. R. F. Post and his associates at the Lawrence Radiation Laboratory, where most of the U.S. mirror research program is carried out, made a virtue of necessity and developed a process to turn the emerging particles' energy directly into high-voltage d.c. power ("Trend of Affairs," June 1971, p. 58). The very high efficiency of energy conversion (efficiencies of up to 83 per cent have been demonstrated in laboratory experiments) mitigated the effect of the rapid particle loss by implying that most of what the plasma lost could be efficiently returned to it without environmental burden. The excess electrical energy would comprise a very high thermal efficiency power source. The combination of classical confinement and direct conversion kept the mirror machine in the running as an interesting concept.

However, a suspicion that has been rumored widely among workers in the field became confirmed fact at this meeting. There is no mirror machine anywhere in the world that is achieving classical, stable confinement. There are, thus, both experimental and theoretical reasons to believe that mirror devices in anything like their present form *cannot* be extrapolated to fusion machines. The final verdict is not in, but circumstantial evidence keeps mounting and the prognosis for mirror reactors at this moment is poor.

An interesting sign of the, at any rate, *psychological* nearness of fusion conditions was the appearance at this meeting of the first session devoted to fusion-power reactor systems per se. The optimism of most of the researchers is perhaps best demonstrated by the convening a week later of an international working meeting on fusion reactor design at the Oak Ridge National Laboratory, which was attended by more than 160 people from eight countries.—*L. M. Lidsky*

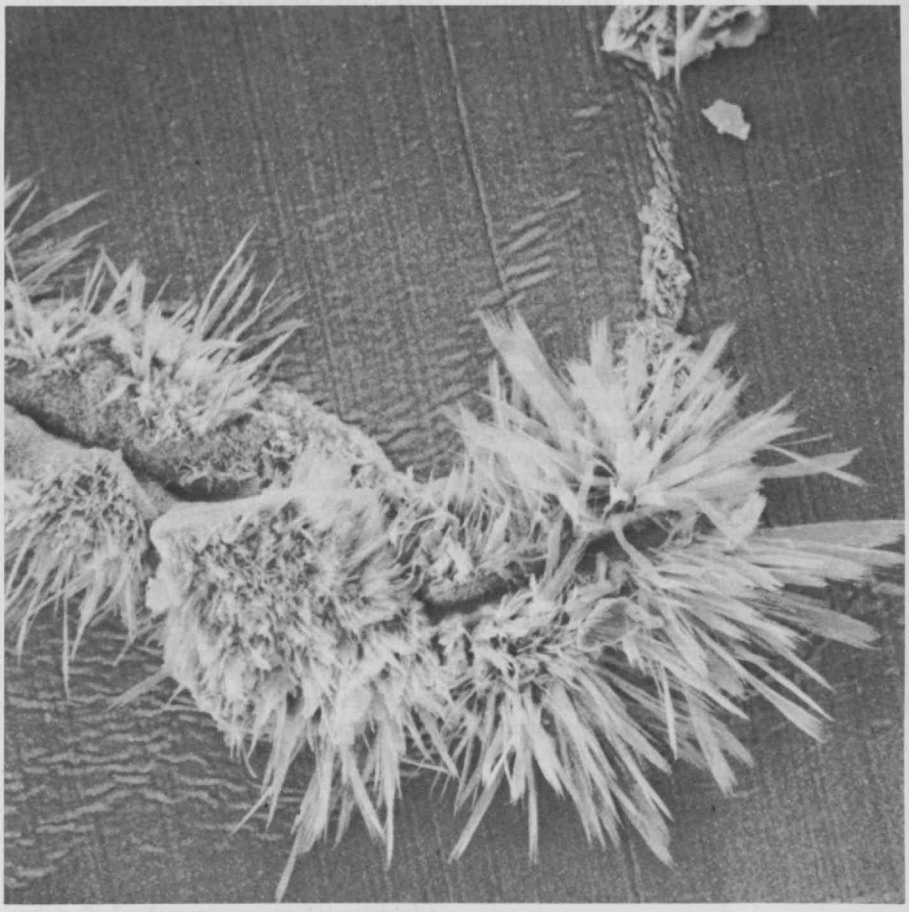
Fatigue and Oxide Whiskers

The normal view of metal fatigue is that this form of failure occurs after a specific number of stress cycles (given the level of stress). The temperature and the presence or absence of a corrosive atmosphere are known to make a difference to the fatigue life of a metal component, but the duration of each cycle is generally not regarded as an important variable.

Research on the high-temperature fatigue properties of "super-alloys" for use in gas turbines, at the General Electric Research and Development Center, Schenectady, N.Y., has led to a set of predictive equations which take into account the duration of the cycle. Dr. Louis F. Coffin (his doctorate is in metallurgy, from M.I.T.) found that when his super-alloy specimens were cycled at high temperatures in vacuum, the cycle frequency made no difference to the number of cycles before failure. In air, the frequency was important.

The process of fatigue, as is well known, is essentially that of the growth of small cracks. What goes on within the metal at the front of an advancing crack, to decide whether it grows and how fast, is the subject of continuing research. At high temperatures, the accepted theory relies mainly on the idea of the diffusion of atoms (creep), whereby the metal locally adjusts itself—or fails to adjust itself—to the changing pattern of stress around the crack. Dr. Coffin's work on the cycle-frequency effect indicates rather that the process of oxidation actually controls crack growth at high temperature.

The photograph shows oxidation at a microcrack in the iron-based alloy A286, widely used in jet engines. The "whiskers," which grew during a high-temperature fatigue test at the General Electric laboratory, are iron oxide.



Iron oxide "whiskers" around a microcrack in a super-alloy subjected to high-temperature stress-cycling in air. A new set of predictive equations for fatigue life take oxidation into account, and are novel in showing a dependence of fatigue life on the duration of each stressing cycle.

LIFE SCIENCES

Whither "Genetic Engineering"?

There is a widespread belief that current advances in molecular biology, genetics, and embryology imply some major threat to society in the fairly near future. The threat is never very clearly defined, but it is supposed to involve the appearance of a new eugenic technology which might perhaps fall into undesirable hands. Serious evaluations of the possibilities are few. One was provided two years ago by Dr. Bernard D. Davis of the Harvard Medical School (*see "Trend of Affairs" for March, 1970, p. 77*). Further contributions have appeared as editorials in two successive issues of *Science* (*Vol. 173, Nos. 3993 and 3994*).

Maurice S. Fox of M.I.T. and John W. Littlefield of the Harvard Medical School concentrate on genetic therapy —the possibility of treating inborn abnormalities by alteration of the sufferer's genetic characteristics. The idea is that missing genetic material could be supplied by one of various agencies such as "infection" with a specifically modified virus.

Techniques presently imagined, the authors point out, would not be applicable in disorders due to dominant genes, a combination of many genes, or the presence of extra chromosomes. This leaves "conservatively, between 100 and 1,000 different disorders," together afflicting about one individual in 1,000. The treatment would presumably be a matter of removing body tissue, genetically altering it, and replacing it; this consideration limits the possibilities further.

"On the whole," write Dr. Fox and Dr. Littlefield, "it does not seem possible that more than a small fraction of the inborn errors could be helped by these techniques, and, with new developments in the understanding of the immune response, these disorders will probably be treated more easily and effectively by tissue transplantation of some sort or enzyme therapy."

The authors then draw attention to another kind of limitation: "Many of the procedures are likely to be mutagenic. . . . Most of the viruses under consideration are tumor-producing." And they conclude by noting that "we are still primarily in a descriptive phase in our understanding of human genetics, with little, if any, idea of how to intervene safely at any level." They request support for further fundamental research and deplore any suggestion of quick practical results.

The following week Philip H. Abelson, Editor of *Science*, went further afield: "Speculation about test tube babies is based on a modest accomplishment—that is, fertilizing a human egg in vitro and keeping it alive for a week or so. For many years, biologists have been fertilizing eggs of countless species in vitro.

"Talk of genetic engineering received impetus from the isolation of an operon, a specific piece of D.N.A. This accomplishment is about as meaningful as the isolation of other components of the living system. Biochemists are experts at taking life apart, and they can reassemble some subsystems. The total system, however, is orders of magnitude more complex than anything they have put together."

However dramatic the progress in a field of science may seem, the application of that science—if and when it happens—may or may not make a dramatic difference to human life. Even the ability to create a genetically novel individual in vitro would not greatly alter the real possibilities for human eugenics, which could have been practiced at any time in the past.

TECHNOLOGIES HIGH AND LOW

After the Moon, Brownsville?

"If we can put a man on the moon, why can't we solve our problems in the cities?" The answer to this well-known question is being defined with ever more precision. Early this summer, in New York, the American Institute of Aeronautics and Astronautics staged a conference on "urban technology." *Aviation Week*, in its reportage of this event (June 7, pp. 62-66), gave special prominence to a paper by Dean S. Warren, manager of market planning and research for the Missiles Systems Division of Lockheed who said, among other things:

"Realistic aerospace marketing men have not been attracted to the field" (the field being the improvement of the cities). "They see all too well that the sales dollar will go for things which aerospace does not produce: land, food, concrete, and the subsidization of low skills. If the system integration is not an aerospace job and there is no hardware, why pursue it?"

"System integration"? Mr. Warren felt that "aerospace program management of a social development would tend to be expensive, unprofitable, and not likely to lead to the kind of diversification so many of us in the industry would like to see. We are big, imaginative, and have a pool of first-rate talent but . . . some things are just too complex and foreign."

But it is also well known that social problems have technological components. *Aviation Week* observed signs that, in the "urban ranks . . . there is a slow march toward the pro-technology camp." Out of a Technology Applications Project undertaken by N.A.S.A. and the International City Management Association (one of the cosponsors of the New York conference) has come a list of 15 technical urban tasks that appear both practical and practicable. Five of them relate to fire fighting, which is indeed a technically backward area:

Communications for firemen
Life-support systems for firemen
Protective clothing for firemen
Better hoses and couplings
Automatic water-pressure regulator

Two relate to policing:
Police command and control
Body armor

Two are in electric power transmission:
Detection of faults in power lines
Improved high-voltage transmission systems

Two are in the health field:
Patient monitoring
Emergency remote patient monitoring

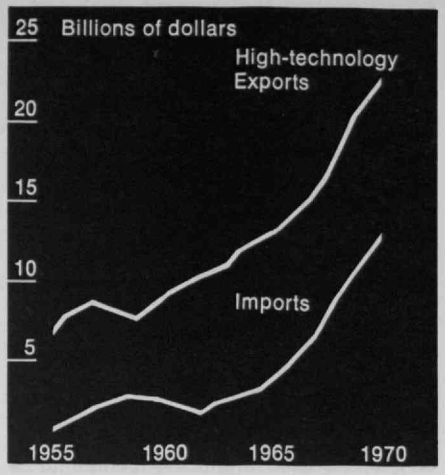
And the other four are:
Disposal of toxic and flammable materials
Traffic counters
Underground pipe detection (needed because many cities have inadequate records of their utilities piping)
Road paint

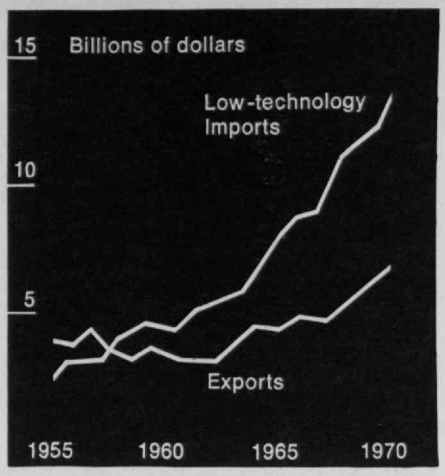
Porter W. Homer, president of the Technology Applications Project, is quoted as saying—lest any aerospace salesman become overexcited—that the list does not constitute a market at this point, but is a step in that direction. It was selected from 400 suggestions.

On the Weakening of U.S. Technology

Less than two weeks before President Nixon made his dramatic effort to revive the U.S. dollar, Maurice H. Stans, his Secretary of Commerce, had given that job to technology.

"Technological development . . . may be our only hope of maintaining a future trade position adequate to support our balance of payments in the years to come," Mr. Stans told the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics on July 27. He was particularly concerned, he said, by U.S. trade losses in low-technology products (from $1.8 billion surplus in 1951-55 to $6.1 billion deficit in 1970); by the differentials between U.S. and





While the U.S. has held its own against overseas competition for high-technology markets (left) since 1950, low-technology products made in the U.S. have fared very badly in international competition (right) in the past two decades. The U.S. trade deficit in low-technology products was $6.1 billion in 1970, according to Maurice H. Stans, Secretary of Commerce; and he told a House of Representatives subcommittee this summer that the deficit will "continue to increase."

foreign rates of investment in industrial research and development—on which J. Herbert Hollomon and Alan E. Harger commented in this magazine for July/August (*p.* 37); and by a declining U.S. productivity growth rate. In 15 years after 1950 U.S. productivity growth trailed that of Europe by 35 per cent, and of Japan by 60 per cent; by 1970 the U.S. had lost still more ground: productivity growth here was 60 per cent behind that of Europe and 84 per cent behind that of Japan.

Some observers may find comfort in noting that foreign nations, in general, started the post-war years from a far lower productivity "base" than the U.S. Mr. Stans does not. Indeed, he said, all the global indicators show "a relative decline in U.S. technological strength."

To stimulate technology and productivity, Mr. Stans listed four options—none of them the program which Mr. Nixon shortly thereafter put together to ease U.S. economic pressures. Mr. Stans' suggestions:

☐ Establish a new agency to act as "a single federal focus for several activities directly related to enhancement, assessment, and forecasting of industrial technology."

☐ Create financial incentives—loan guarantees, cost-sharing, grants, and tax rebates—to stimulate industrial investment in research and development.

☐ Free industries from some legalistic burdens which do not operate overseas—especially the U.S. anti-trust laws which prevent effective research and development cost-sharing.

☐ Develop strong standards to assure the quality of U.S. manufactures—and to increase the demand for them overseas.

Testing Aerospace-Urban Conversion

When the National League of Cities, U.S. Conference of Mayors, and Departments of Labor and of Housing and Urban Development last spring announced a $1.3 million pilot program to help unemployed aerospace engineers turn themselves into urban experts, there were nearly 7,500 applications; 400 were finally selected, 200 each for programs organized this summer at the University of California (Berkeley) and M.I.T.

It turned out that Jerome B. Wiesner, President of M.I.T., was right when he told the 200 members of the Institute's Project ADAPT (Aerospace and Defense Adaptation to Public Technology) on their arrival: "We don't want to deceive you by suggesting that in one month we can retrain you, or make you planners in a year. But we want to give you some feeling of how people in these urban disciplines think and work."

To that end the retraining candidates who came to M.I.T.— mostly from the east coast, mostly unemployed (some for as long as 15 months) after careers in middle-management or engineering, 12 of them alumni of the Institute—spent four intensive weeks simply making an acquaintance with four broad topics, one each week: urban growth and development, or how people interact with each other in the process of building the city; the ecology of the city, or how people interact with their surroundings in the urban environment; urban management, or how public services—health, waste disposal, utilities—are delivered; and urban institutions, including how professional and political issues interrelate.

The M.I.T. program, directed by Francis T. Ventre of the Department of Urban Studies and Planning, was organized as a series of lectures, panels, and evening forums. In the middle came a two-day "Urban Reconnaissance," in which participants were turned loose to experience the city and its problems "from the user's point of view." They travelled on public transportation, watched people and their reactions to their environments, and visited many neighborhoods.

Did Project ADAPT work? It's too early to tell, in almost every respect. As the Project closed at the end of August, Michael A. DiNunzio of the National League of Cities was enthusiastic, confident that by the end of September "a majority" of these unemployed engineers will be at work in urban management or other public jobs. Even before the program ended recruiters had been busy and some jobs filled. But Mr. DiNunzio's task has only begun, for the H.U.D. and Labor Department funds cover a long-term follow-up of the engineers' successes, failures, satisfactions, and frustrations in their new careers.

Ask the same question of Mr. and Mrs. Leonard Buckle, who are both Instructors in the M.I.T. Department of Urban Studies and Planning and were Mr. Ventre's Associate Directors of Project ADAPT, and they are not so sure, agreeing that it's too early to answer. The Buckles think the real successes of the program will be made by those who already had "some experience or special understanding of government." They were the ones who came to sense the broad opportunities.

Will the sophisticated techniques of aerospace technology be applicable to urban problems? There is ample convertibility of skills—especially in management systems and problem analysis, says Suzann Buckle. "But our attitude," she says, "was that we were teaching not problem-solving tools but problem-solving approaches. We concentrated on the role and style of the professional working in the urban environment—where information is inconsistent, organization complicated and disjointed. So we talked more about personal skills than the hard engineering relationships."

Puzzle Corner

Allan J. Gottlieb

A "Most Interesting" Number

A great deal happened this summer. The excitement of planning for a year in Santa Cruz was severely tempered by a family loss: my mother suffered a heart attack on July 13 and died early the following day. Since she enjoyed reading this column, I dedicate this installment of Puzzle Corner to her memory.

Since this issue is the first in a new volume, here are the "rules" for Puzzle Corner: every month we publish five problems and several "speed problems," selected from those suggested by readers. The first selection each month will be either a bridge or a chess problem. Three months later we select for publication one of the answers—if any—to each problem received by then from readers, and we publish a list of other readers submitting correct answers. Answers received too late or additional comments of special interest are published as space permits under "Better Late Than Never." Except under unusual circumstances, no answers or discussions are published concerning "speed problems." As you see, readers' participation is not only welcome; it's essential to the success of "Puzzle Corner." Address problems and answers to me at the Department of Mathematics, University of California, Santa Cruz, Calif. 95060.

Problems

Our bridge problem for this month is from John W. Meader, who calls the following "an easy little bridge problem":

41 Given these hands, against South's contract of six diamonds, West leads ♥Q:

	♠ A K 5 ♥ 10 7 4 2 ♦ Q J 7 6 ♣ J 10	
♠ 10 4 ♥ Q J 6 5 ♦ 10 9 4 2 ♣ 9 7 6		♠ J 9 8 2 ♥ 9 8 3 ♦ 8 ♣ K Q 5 3 2
	♠ Q 7 6 3 ♥ A K ♦ A K 5 3 ♣ A 8 4	

How does South manage to bring home a small slam?

The following problem from E. A. Nordstrom is an offshoot of last year's number 37:

42 What is the smallest number (N) of n digits which, if you remove the digit (d) from the units place and relocate it in front of the n's place, exactly multiplies the number N by that digit d? The answer: N = 1. Since that is too easy, replace ". . . n digits . . ." in the problem as originally stated with ". . . n digits ($n > 1$). . ."

Art Delagrange has discovered "a most interesting number" and offers everyone a chance to play with it:

43 The number is 012345679 (8 is missing): in the range 0 to 81, multiplying by any multiple of 9 gives an answer with all digits the same; multiplying by any other multiple of 3 gives an answer containing three different digits; multiplying by any other number gives an answer containing nine different digits (none repeated); and the missing digit is cyclical with increasing multiplier except that 0, 3, 6, and 9 are never missing. Why?

A trigonometry problem has been supplied by Frank Rubin; it was published in *Electronic News* "some time ago," Mr. Rubin writes, "but the contributor did not provide any proof of his answer." Can you?

44 Find the set of angles x and y for which $\sin(x + y) = \sin x + \sin y$; and prove that your set is exhaustive.

Here's a problem for all the G-men in the crowd. It was submitted by Robert Baird, but I have also heard it over dinner from a former M.I.T. roommate, Martin Aldridge:

45 You are given a stack of 12 coins, which appear identical to one another, and are told that one is counterfeit and can be distinguished only by its weight, which is not the same as the genuine coins. Unfortunately, you do not know whether the counterfeit coin weighs more or less than the genuine ones. Using only a balance, how do you find the counterfeit in a minimum number of balancing operations? (As a hint—if you need one—the minimum number of weighings is three.)

Speed Problems

Here's one from Ely Shelleen:

What day of the week (if any) can never be: (1) February 29; (2) The first day of a new century?

Greg Schaffer wants you to prove:

For all real x and positive integers n, $2 \leq (1 + x)^n + (1 - x)^n$

Solutions

31 South has rashly bid six spades:

	♠ 2 ♥ A Q 10 9 8 7 ♦ A K Q ♣ J 3 2	
♠ 6 5 4 3 ♥ K J ♦ 8 7 ♣ K Q 10 9 4		♠ 10 9 8 7 ♥ 6 5 4 3 2 ♦ 6 5 4 3 ♣ —
	♠ A K Q J ♥ — ♦ J 10 9 2 ♣ A 8 7 6 5	

How can South make the contract against a spade lead?

The following solution is from Leon Kaaty, who found the fact that East had only one conceivable entry a "dead giveaway": The declarer wins the opening spade lead and cashes his four top spades, discarding the ♦A, ♦K, and ♦Q in dummy. Next the ♦J, ♦10, and ♦9 are cashed and dummy's three clubs are discarded. Declarer now leads ♦2, throwing off a low heart from dummy. At this point East is the only player with a diamond remaining, and he is forced to win the trick; but he has only hearts left thereafter. The forced heart return gives the declarer a free finesse which he takes. Upon cashing the two high hearts in the dummy, West's ♥K and ♥J fall, establishing North's heart suit to win the rest. The problem was also solved by 33 other bridge fans—the list is too long to print—including the proposer, Edwin G. Davis.

32 Prove that a regular icosahedron having the same volume as a regular dodecahedron has the same perpendicular distance from the center to a face.

Norman L. Apollonio is hereby unanimously declared guilty of submitting an incorrect problem. The following proof was supplied by the foreman of the jury, Kard Jan Bossart: According to the problem, icosahedrons and dodecahedrons of equal volume would have equal inscribed spheres. This goes contrary to intuition; the 20-faced solid should be a closer approximation to the sphere than the 12-faced one. This led me to compute the table below (to slide rule accuracy) for the ratio of the volumes of polyhedron to inscribed sphere:

Sphere	Icosah.	Dodecah.
1	1.20	1.33
Octah.	Cube	Tetrah.
1.56	1.91	3.31

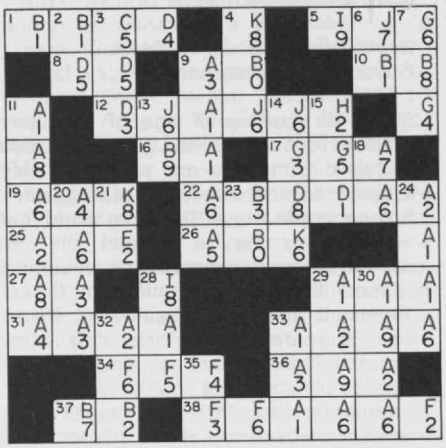
It appears that—for once—my intuition was right and that consequently Mr. Apollonio was wrong. (Mr. Bossart follows this with an analysis developing the volume of the two polyhedrons in terms of the radius of an inscribed sphere: in the icosahedron, $V = 5.02r^3$; in the dodecahedron, $V = 5.58r^3$. Space does not permit publication of his development.) Three other jurors concurred: Ted Leahy, William Ackerman, and R. Robinson Rowe.

33 Two players play a game in which each player alternately selects dates of the year subject to the restrictions: (1) The first date must be in January, and each subsequent selection must (2) agree with the immediately preceding date in either month or number and (3) be later in the calendar year. The winner is the player who is able to select December 31. Which player has the advantage and what is the winning strategy?

John G. Miller writes: The game favors the first opponent to pick January 20 or the next applicable date in the following sequence: February 21, March 22, April 23, May 24, June 25, July 26, August 27, September 28, October 29, November 30. The strategy is: once on the sequence, stay there. If your opponent starts by picking January 1 through January 19, you pick January 20. If he picks January 21 through January 31, you pick the later month which corresponds to his day of the month. Any time he picks a lower day of the month than the sequence shows, choose his month but raise the day of the month to the sequence. Any time he raises the day

of the month beyond that of the sequence for that month, choose the later month in the sequence that corresponds to his numbered day. If he starts with January 20, stay loose and see if he knows the sequence. There were 22 other successful strategists—once more, too many to list—including the proposer, John E. Prussing.

34 In the crossword printed below, the problem is to determine the total quantity of vehicles (both types A and B) purchased (horizontal 5). It is known that the center of gravity (CG) of type A vehicles is identical to that of type B vehicles. The customer bought some A vehicles and some B vehicles. All values are positive whole numbers. There were 45 charter members of the Society of Aeronautical Weight Engineers (S.A.W.E.). Use the speed of light as 186,284 mi./sec., and 4,633 lb./in.sq./slug ft. sq.



Horizontal:

1. Weight of vehicle A.
5. Total quantity of vehicles A and B purchased.
8. Sum of digits of 22 horiz. and 11 vert.
9. Robert's age.
10. Age of the second Fred in Robert's family.
12. Total cost of vehicles A and B purchased.
16. Sum of the ages of the three Freds in Robert's family.
17. CG of forward section of vehicle B.
19. Weight of aft section of vehicle A.
22. Moment from station O of vehicle A.
25. Unit price of vehicle A.
26. Weight of forward section of vehicle A.
27. Weight-reduction ideas considered, but not implemented, for vehicle B.
29. Non-prime number.
31. Next in series 7, 6, 5 . . .
33. Product of the ages of the three Freds.
34. Weight of vehicle B.
36. Unit price of vehicle B.
37. Age of eldest Fred.
38. Moment from station O of vehicle B.

Vertical:

2. Cost-increase weight-reduction ideas implemented in vehicle B.
3. CG of vehicles A and B.
4. CG of aft section of vehicle A.
6. Cost-decrease weight-reduction ideas implemented in vehicle B.
7. CG of aft section of vehicle B.
9. Robert discovered that when his name was arranged as a division problem, there were four numerical solutions:

$$J\overline{)\,ROBERT}\quad ENNIS$$

One quotient is 311 - - .

11. Speed of light (*).
13. Greater than 60.
14. Greater than the square of the age of the eldest Fred.
15. Total weight-reduction ideas considered for vehicle B.
18. LXXVI.
20. Lb. in. sq. per slug ft. sq.
21. No-cost-change weight-reduction ideas implemented in vehicle B.
23. Robert's age. He is 12 years older than the middle Fred.
24. Square of the number of charter members of S.A.W.E.
28. Quantity of vehicles B purchased.
29. Square of atomic number of krypton.
30. Year of election of the 70th U. S. Congress.
32. Weight of forward section of vehicle B.
33. Decimal equivalent of the binary 10,000,011.
35. Prime number.

M. A. Clark, writing all the way from Rome, has submitted a most detailed analysis of his method of solution, which is far too long to print here; readers wishing copies should write to the Editor of the *Review*, Room E19-430, M.I.T., Cambridge, Mass. 02139. The crossword in the left column shows the solution in black numbers and the sequence of stages in which Mr. Clark completed it in grey letters. Mr. Clark found clue 30V the most difficult—he "had to be assisted by an American!" There were also solutions from the proposer, John Mandl, and from William Ackerman, John C. Ebert, Robert C. Fleetham, Robert H. Griffin, R. Robinson Rowe, Sammy Loebl and Loren Bonderson jointly, and one anonymous reader. This is exactly five more solutions than received by the S.A.W.E. when the problem was published in that Society's *Journal.*

35 Given the following sequence of numbers:
1,2,1,3,2,1,2,3,4,1,2,1,3,2,1,2,3,5,2,3,4,1,4,3,
1,4,5,2,3,1,5,2,1,2,4,6,1,2,1,4,2,1,2,6, . . .
find the method of formation.

As expected only the proposer, Preston Bush, solved this problem: Elements of the sequence are formed consecutively and are as small (integers > 0) as possible without violating two rules: (1) No two consecutive blocks of numbers can be identical, e.g. 1,2,1,2, is not allowed and 1,1 is not allowed; and (2) No three equally spaced numbers can all have the same value, e.g. *1,2,1,3,1* is not allowed. According to the second rule, for example, the 10th and 15th elements are 1 so the 20th cannot be, and elements 21 and 26 are 4 so element 31 cannot be.

Better Late Than Never

Late responses have been received as follows:

12 William Ackerman.
21 R. H. Gaunt and John E. Burchard.
23 Smith D. Turner.
24 Ann Giffels.
26 W. C. Backus.
27 Harold Donnelly.
29 Harold Donnelly.

In addition, A. R. Latven submits the following discussion of problem 24 which will interest many readers: Despite your evident uncertainty, the solution to the problem given by D. R. Wheeler in *Technology Review* for June is unquestionably correct. One of my favorite fun-flights as a private pilot confirms that geo-algebraic calculation. I release a constant-altitude balloon into a wind of unknown velocity and bee-line my 3-km./min.$^{-1}$ aluminum bird in *any* compass direction chosen by my companions for a precise leg of 30 minutes, then turn 180° and exactly 30 minutes later my prop bursts that balloon every time. It's quite a thrill to see the balloon suddenly appear head-on within seconds of the projected time, sometimes as far as 30 kilometers from the point of release! The fun part comes from not knowing just where the collision will occur geographically.

The collision point, of course, is point 2 in Wheeler's diagram; it represents the point to which a balloon is carried by the prevailing wind in the period of time under consideration. It also represents the direction and distance of drift of all aircraft regardless of compass heading or airspeed. A 747 will drift just as far, no more and no less, as a Piper Cub in the same period of time. Thus if, simultaneously, a 747 started out northward, a DC-3 eastward, a Lear Jet southward, and a Piper Cub westward—and each proceeded as described all four craft would converge upon point 2 exactly two hours later. What a mess!

Finally, let me point out that the problem as given is specious at best. Upon reaching point 2 after two hours the pilot is said to turn straight to the point of departure. If he doesn't know where he is, he cannot perform this maneuver. If he does know where he is, he must know the distance to the point of departure and thus can calculate windspeed simply by dividing that value by two. You might say that the final turn can be accomplished simply by turning directly into the wind. True enough. However, he has no means of determining wind direction accurately. Tracking the shadow of a cumulus cloud yields a crude approximation at best; even if he looks down upon the long plume from a tall smokestack he knows that it points the direction of the surface wind and that all surface winds shift counterclockwise because of the lessened Cariolis force, often 20° or more. Thus the final turn can only be accomplished effectively above an industrial complex situated on the equator! But this was not included in the problem.

The latter has provided some excellent mental exercise, to say the least!

Books

George A. W. Boehm, Francis W. Sargent. Robert Sanders, Irwin W. Sizer

On a Computed World

World Dynamics
Jay W. Forrester
Wright Allen Press, Inc., 238 Main St., Cambridge, Mass., 1971, $9.75

Reviewed by
George A. W. Boehm
Editorial Advisory Board,
Technology Review

Thirty years ago in the first volumes of *A Study of History,* Arnold J. Toynbee set forth his theory of why civilizations come and go. They rise and flourish, he said, in response to stresses that are great enough to be stimulating. They fall when pressures become so great as to cause a kind of universal despair, ending in a collapse of morale.

A condensed version of Toynbee became a best-seller in the late 1940's, possibly because readers found his message rather a relief from the frantic worries of World War II. If civilization was running downhill, at least it was doing so gradually. Anyway, why bother? Decline was inevitable, and Toynbee offered a rationale for accepting old age and death with dignified resignation.

Today's social philosophers are not nearly so ready to accept the disintegration of civilization. They see it menaced by overpopulation, food shortages, pollution, depletion of natural resources, and other concomitants of exceeding speed limits. Yet the people most deeply concerned about these threats are eager to search for recipes for postponing doom indefinitely. They are even willing to consider ascetic programs involving severe limitations on birthrates, food consumption, and the exploitation of resources.

Social Philosophy for Today

In his latest book, *World Dynamics*, Jay W. Forrester is a social philosopher in step with the times. As many readers of *Technology Review* will recall, his ideas about the ills of the world and how to ameliorate them were summarized in his article in the January, 1971, issue (*"Counterintuitive Behavior of Social Systems," pp. 52-68*). Briefly, he urges a drastic deceleration in the pursuit of affluence. The wealthier nations must move backward a generation or more in the production of material wealth, and the emerging nations should attempt to emerge no further.

Growth for growth's sake, a universal ideal through most of history, has now become perilous for all mankind, says Professor Forrester. The challenge today throughout the world is "how to handle the transition from growth into equilibrium." Meeting this challenge is going to require a form of resignation much less despairing than the one suggested by Toynbee. Man will have to settle for less than he has today, in what Forrester suspects may be the end of the "golden age." But if he manages wisely, the world will remain a reasonably good place to live in.

In one tentative analysis, for example, Forrester envisions the results more than a century hence of some deliberate pullbacks. The reductions would be as follows: usage of natural resources by 75 per cent; pollution generation by 50 per cent; capital-investment generation by 40 per cent; food production by 20 per cent; birth rate by 30 per cent. Population would decline slightly below the 1970 level and "quality of life" would stabilize at a slightly higher value.

The main difference between Forrester and other social philosophers who counsel restraint is his use of an elaborate mathematical model of the clockwork that makes the world run. He simulates civilization with an interlocking network of feedback control loops, made up of such elements as the rate of natural resource usage, amount of food per person, changes in capital investment, and effects on quality of life due to pollution, crowding, and material possessions. All the factors react in ways that defy human intuition to predict—a point he has hammered at previously in *Industrial Dynamics* and *Urban Dynamics.* But such dynamic systems, like unimaginably complex machines, can in principle be analyzed with computers.

Forrester makes no claim that his model is perfect and will promptly yield recipes for maintaining civilization at an acceptable level. But he does maintain that with repeated refinements it will suggest ways for political leaders to chart the course of the world a century or more ahead. Forrester has gone about his work with his usual painstaking skill, and his model seems far more realistic than other simulation schemes of such scope.

Modellers vs. Users of Models?

Yet, even as an ardent Forrester fan, I have some serious doubts. Is there any guarantee that with repeated refinements any model of an extremely complex system will ever approach reality closely enough? A quarter of a century ago, it was widely supposed that weather forecasting would become an exact science as soon as a few more weather stations were built and computer speed increased by a factor of ten. That hope has remained a dream, and it may turn out that the dynamics of all humanity can never be simulated in sufficient detail because they are too complex.

More troubling is the question whether a working relationship can ever be effectively established between men who make models and men who ought to use them. Can the rulers of a developing nation be expected to refuse foreign aid to acquire a steel mill, an automobile assembly plant, a two-plane airline, or any other symbol of national prestige? It is hard also to imagine a U.S. presidential candidate stating: "If you elect me, I will provide much less for you and your children in order that your grandchildren and their children will not have to do without."

Forrester himself expresses some doubts along this line when discussing some of the specific recommendations generated by his simulation: "Reduction of investment rate and reduction in agricultural productivity are counterintuitive and not likely to be accepted without extensive system studies and years of argument—perhaps more years than are available." In this statement there is, unfortunately, no conflict with Toynbee.

The International Environment

Man's Impact on the Global Environment
Report of the Study of Critical Environmental Problems
M.I.T. Press, Cambridge, 1970
319 pages, $2.95 (paper)

Reviewed by Francis W. Sargent
Governor of Massachusetts

Since the coming of age of the "environment movement," the public has been barraged with facts and statistics which support a wide spectrum of arguments. Some people claim that the world cannot possibly survive beyond the next decade since it is already too polluted to support life. Others argue that the environment today is "healthier" than it was 50 years ago. Unfortunately sensational headlines are a very effective means of attracting public attention. I sometimes fear that too much of the present concern relative to environmental matters stems directly from these portends of imminent doom.

This book reports a 1970 summer conference sponsored by M.I.T. to confront the problems raised by this information gap. Few conferences on the subject of the environment have brought together men of such high calibre and expertise for such a long period of time. The information and recommendations generated during the conference represented a major addition to our knowledge of our environment. These recommendations are of particular value to those in government who must make policy decisions on a day-to-day basis, since they draw an accurate and concise picture of where we are in terms of our available data in all areas affecting the global environment.

The reports of this Study of Critical Environmental Problems, published as *Man's Impact on the Global Environment,* give a very specific blueprint of what man must do to understand the effect of his actions, both present and future. There are significant recommendations as to what information must be obtained and how it should be utilized. It is now up to us to undertake these predefined tasks.

We must begin to accumulate sufficient data on existing resources and the quantity and nature of the pollutants we are releasing. We must develop mechanisms by which to use this data to interpret effects of man's actions, and finally we must set up monitoring systems to keep

us informed as to the status of and changes in our environment.

Research and Monitoring

Many possible courses of action can be proposed to achieve these goals; I discuss here two or three which I believe are of paramount importance.

One of the most pressing tasks in the United States is a national inventory of our existing natural resources. Such an inventory would cover not only animal and mineral resources but would strive as well to obtain data on some of the basic chemical components of life, such as water, oxygen, nitrogen, and others. Both President Nixon and Senator Henry Jackson (D.-Wash.) have included provisions for a limited resource inventory in their proposals for a national land use policy. I support these provisions as a much-needed first step in the right direction.

Three months ago I testified in Washington on behalf of a bill which would create a program of National Environmental Laboratories (*see "The Case for National Environmental Laboratories" by David J. Rose in* Technology Review *for April 1971, pp. 38-47*) to study existing threats to our environment, to discover through research the new techniques we will need to solve the problems we face, and to identify in advance the new threats that our technology may create. I was especially interested in the section of the bill which would allow the laboratories to contract projects to nongovernmental organizations and institutions. This would give us a chance to rechannel into environmentally oriented projects some of the funds previously contracted to the private sector for defense oriented projects.

Although the National Laboratories would provide some funds for monitoring, I agree with the study report that monitoring to be effective must be conducted on a global scale. Pollutants do not observe international boundaries; wastes dumped into the Colorado River do not disappear at the Mexican border. In the next 20 years this situation will grow more serious as public work projects become larger in scale and the underdeveloped countries of the world gain greater technological expertise and achieve increased rates of industrial growth.

These countries have accepted the priorities of the major developed nations—priorities which stress the need to increase production to meet the expanding demands of their people. In the underdeveloped countries such demands are often for the bare necessities for sur- not observe international boundaries; vival, not from a penchant for greater convenience. We cannot ask these countries to remain in their present state of poverty; yet we must realize that presently most of the world's pollution emanates from a limited number of sources. What would be the fate of our air if all the countries in South America combined to emit the same amount of air pollution as emitted in the United States today? It is quite clear that we must have some type of global monitoring and perhaps eventually some international control.

Politics and Hypocrisy

The study which this book reports was called in anticipation of the United Nations Conference on the Human Environment in Stockholm, Sweden, in June, 1972. Though we may hope that this Conference will direct itself to the feasibility of setting up a worldwide environmental organization, either within the framework of the United Nations or outside, that will act to coordinate a global effort to monitor our environment, I do not believe that such an organization will be easy to develop. Some very real questions must be answered. Who will pay for such a monitoring system? And how can it function?

I doubt that some countries will allow an international group of scientists to set up monitoring stations within their borders. Some will argue that the presence of a monitoring team is an infringement upon their sovereignty and a first step towards international control of their economic destiny. In fact, preliminary diplomatic soundings indicate that any type of supranational review will not be acceptable to many of the nations involved.

There is an obvious corollary between economic growth and pollution, and it is those nations which have achieved a high level of growth which are now becoming most concerned with the quality of the environment. It would be somewhat hypocritical for a developed nation to tell an underdeveloped country that environment considerations merit priority attention. At the same time many of the developed countries have established economic and political rivalries which would make any curtailment of economic production or increase in costs very difficult.

Not Without Hope

I believe that these questions can be answered. We are not working in altogether uncharted waters, for the United Nations has already worked to set up various worldwide agencies including the World Health Organization and the World Meteorological Organization. One idea which has gathered support calls for an International Center for the Environment which would conduct research into various environmental problems and supply technical assistance to nations requesting it. Another idea is to center efforts on one issue such as the pollution of our oceans. One could argue that if an effective effort could be made to cooperatively solve a major international pollution problem, a precedent would be set which could be expanded into other areas.

Man's technological advances in the last two centuries have been tremendous, but now man must insure that he can harness these achievements in such a way that they are a benefit to all his kind and not an albatross around his neck. In order to achieve this end he must find out more about the present state of his environment and its future. He must remove his blindfold and learn about the strengths and limitations of his world.

Neuron and Psyche

The Mind of Man
Nigel Calder
The Viking Press, New York,
288 pp., $0.00

Reviewed by
Robert Sanders
Department of Psychology, M.I.T.

In *The Mind of Man,* Nigel Calder gives the general reader an accurate and interesting picture of the various researches that have lately come to be called "brain science" and that may one day have something to do with a science of the brain. As things stand now, when there is no such science, this book perhaps represents its subject as well to the brain researcher as to the layman: a kaleidoscopic image of diverse activity.

Calder distinguishes and describes the various types of experiment and important schools of thought in a broad dispersion of fields: studies of brainstem mechanisms affecting arousal, sleep, dreaming, emotions, and fundamental drives; efforts to define the psychological function of cortical regions; speculations and experiments on the physical nature of memory; the neurology and psychology of developing organisms, and the tenuous criss-cross of inferences between them; and language, regarded so differently by neurologists, psycholinguists, and those who seek to teach human-like communication skills to chimpanzees. He reports these and other pursuits in the mood of an intelligent, reflective journalist at the scene, getting the news for intelligent readers.

The book has an air of telling one what one wants to know, not what one must learn in order to be qualified to inquire. When he is forced to explain the conceptual underpinnings of a subject, Calder is succinct and effective—in general, he introduces necessary technical material without distorting it or distracting the reader, often presenting it in marginal diagrams, with only passing reference to it in the text. This technique works insofar as the diagrams are adequate, and usually they are excellent. Overall, *The Mind of Man* achieves as much as could be expected: a distinct feeling for what the whole enterprise is like, and what, for good or ill, is accepted within that enterprise as progress.

How Our Brains Do What We Do

The book abounds in stimulating intimations. Very seldom does Calder have to argue the "human interest" of an experiment by connecting it explicitly to some thought or value the reader already takes as his own. Suggestions that someone knows where to put electrodes in your head to throw you into a rage or to give you some inarticulate delight, or that your rate of metabolism can be brought under the control of your will, or that a speaking and a mute consciousness, co-existing in your single head, can be divorced by surgery and concealed from one another, are provocative merely to mention. And because we all have wondered, however vaguely, how our brains do what *we* do, it is pleasing to be told that science is about to spell out the physical basis of memory, the mechanisms of vision, or the neurology of willed actions.

The Mind of Man is a sanguine book. Calder speaks of " . . . a great enlargement of knowledge . . . about how the mind of man works," and announces that " . . . barriers to understanding are collapsing. . . ." Although he is not always so exuberant (" . . . everything that has gone before could be said to be thoroughly misleading, if it gives the impression that the brain has surrendered its secrets and the scientists are just mopping up the details"), he is always confident that great progress is under way, that fundamental discoveries are in the works. In his view, what remains for "brain science" is essentially an amplification (a huge amplification, he admits) of our neurological and psychological knowledge, in its *current form.*

A Conceptual Void

This view, which is not peculiar to Calder but seems to be part of the *Zeitgeist* of physiological psychology, is wrong. There is a logical discontinuity between our present descriptions of physical mechanisms and our present apprehensions of psychological phenomena, such that we could learn indefinitely more about neural activity without learning any more about mental activity, or accumulate any number of new psychological facts without improving our conceptions of their physical embodiment. Indeed, the more precise our description of a neural mechanism, the fewer and more trivial are the deductions that can be made from it as tests of psychological theories. And conversely, the more realistic and discriminative our description of an item of behavior, the less we can say about the particular brain functions corresponding to it.

It is not simply that we have yet to discover facts enough, and to refine our measurements sufficiently, but rather that we have yet to conceive of fundamental neurological and psychological entities that will fit together in a single logical framework. Until the unpredictable day of that achievement, there will be no "great enlargement of knowledge about how the mind of man works" forthcoming from brain research; after that day, we will apprehend both mind and mechanism in ways that are certainly not immanent in present discourse.

The Nervous System as Science

The Neurosciences—Second Study Program
Francis O. Schmitt, Editor-in-Chief
The Rockfeller University Press, New York, 1971, 1100 pp., $30.00

Reviewed by
Irwin W. Sizer
Dean of the Graduate School, M.I.T.

The subject of the nervous system and its associated sense organs has matured to the point of becoming a science (or a collection of sciences, the neurosciences) in its own right. The problem of mapping so vast and diffuse a field was attacked in 1966 when the Neurosciences Research Program, sponsored by M.I.T. and organized under the chairmanship of Institute Professor Francis O. Schmitt, called together a group of 153 scientists to meet for a month in Boulder, Colo., to summarize their contributions to the field and indicate prospects for relevant research. This conference resulted in a 962-page publication (the forerunner of the present volume) entitled *The Neurosciences, A Study Program,* edited by Gardiner C. Quarton, Theodore Melnechuk, and Francis O. Schmitt and published in 1967 by the Rockefeller University Press. In this first volume, major topics covered by 153 reviewers included components of the nervous system, molecular biology, molecular biology of brain cells, neuronal physiology, brain correlates of functional behavioral states, brain correlates of learning, and a number of interdisciplinary topics.

The first volume would seem to leave little to be considered by a second study program of the neurosciences, but nothing could be further for the truth. Before one examines the Second Study Program in detail, however, it is worth-while to inquire how the two volumes came to be published and to raise the question of the possible future need for a third volume in view of the fact that the field has now been reviewed so handsomely.

A Fractured Golden Opportunity

In the latter half of the twentieth century the problem of the development and functioning of the nervous system, especially the human brain, has become one of the most exciting and potentially rewarding areas to challenge the capability and creativity of our most able scientists. Despite this golden opportunity for research, the field of the neurosciences was fractured into encapsulated, highly specialized subdisciplines; the result was a lack of dialogue—let alone cooperation in research—among concerned scientists and medical investigators. For example, biochemists and biophysicists working on the brain at the molecular level were so isolated from the systems-minded neurophysiologists and behavioral scientists that a joint attack on the mechanisms of the human mind was not possible.

It was to bring about a new synthesis of knowledge in the neurosciences and to stimulate a collaborative interdisciplinary approach to research in this area that Professor Schmitt (now Emeritus), in 1962 (with support from M.I.T.) organized the Neurosciences Research Program, which has headquarters in the House of the American Academy of Arts and Sciences in Brookline, Mass. The Program is dedicated to the advancement of the science of brain and behavior; this goal is chiefly implemented through conferences bringing together scientists from all parts of the world to review, discuss, and formulate plans for future investigations based on recent advances in the various specialties of the brain and nervous system. The Program has a small permanent professional staff and real profes-

sional strength derived from its outstanding faculty ("Associates") drawn from universities throughout the world. Some 37 distinguished scientists (a half dozen are Nobel Laureates)—experts in neuroscience at levels which include the molecular, the cellular, the neural net, and the behavioral—serve as Associates and guide the Neurosciences Research Program with respect to its organization, its funding, and especially its planning and execution of its various conferences. The Associates are indispensable in enabling the N.R.P. Staff to develop a worldwide information-gathering network.

Defining the Scope of Neuroscience

Although its idiom of operation varies, the N.R.P. staff and Associates began its conference activities with work sessions which examine a single topic in depth for three days with brief formal presentations of recent research in a specialized area followed by intense informal discussion, and which emphasize the broad implications of the specialty with an attempt to identify potentially fruitful future research areas in neuroscience. It soon became apparent that another type of conference was needed better to define the scope and content of modern neuroscience. Hence in 1966 the month-long Intensive Study Program at the University of Colorado in Boulder which brought together famous world scientists and promising young fellows to explore all the critical areas of neuroscience. This resulted in the first volume —*The Neurosciences—A Study Program*, the most extensive and comprehensive monograph ever written on this subject.

So swift are the advances in this critical field that three years later, in 1969, it was necessary to hold a second Intensive Study Program in Boulder, at which some 87 experts presented reviews. It is these which are collected in the 1068-page volume now under review. Dr. Schmitt served as editor-in-chief, but the book is organized into eight subdivisions, each of which had its own editor.

In general, the second volume adds the approaches of evolution and development to the functional anatomy of the first. It contains some 87 chapters which cover the field from "The Theory of the Master Gene" to "General Principles of Neuroendocrine Communication." Although much of the material is highly technical, it is presented in such a way that it is not only understandable but interesting and exciting to the nonspecialist—I speak from personal experience after listening to the presentation and discussion of all 87 topics at the Boulder conference.

Plans are already far advanced for a 1972 Intensive Study Program which will result in *The Neurosciences: Third Study Program*. Although the general format will be similar, a special attempt will be made to review twelve significant fields—in contrast to the previous broad array of topics—since it is felt that the earlier volumes intrinsically established the limits of the neuroscientific domain. The quality of the investigators who have already agreed to participate is such that this third symposium and the resulting volume should be worthy successors to the two outstanding earlier ones.

Institute Review

Alumni Fund: a New Level of Support and Commitment

For the sixth consecutive year, the M.I.T. Alumni Fund has posted a new record in the total number of donors, reaching 44 per cent of the alumni body. And the "impressive" total of $2,564,395 in gifts in 1970-71 was the second highest in the Fund's 31-year history. Howard W. Johnson, Chairman of the Corporation, called it "a remarkable expression of alumni commitment to the Institute."

The 1971 Alumni Fund received gifts from 21,344 alumni, 4 per cent more than have ever before given in a single year. "Alumni support, participation, and interest have never been higher," Kenneth S. Brock, '48, Director of the Fund, said in a statement released by the M.I.T. News Office. "There is an increasing awareness among our alumni of the financial burdens confronting higher education today, a growing sympathy with the university in contentions over political and social problems, and a willingness and desire to help.

"Over 2,000 alumni volunteers worked on this Alumni Fund campaign," Mr. Brock said, "and their enthusiasm dispels further any idea that large numbers of alumni are decreasing their commitment to their alma mater."

Howard L. Richardson, '31, Chairman of the Alumni Fund Board, attributed the year's success to four factors: "a heightened awareness that even the best-managed private institutions require an increase in philanthropic support to maintain their leadership"; continued recognition by alumni that M.I.T.'s excellence in technology represents a powerful thrust for the solution of "society's most vexing problems"; subsiding of the "trauma" induced among alumni by recent campus unrest; and the continued service of over 2,000 alumni who worked hard for the Fund.

"The role of the Alumni Fund volunteers should not be underestimated, nor can our thanks be adequate," Mr. Richardson said.

Alumni giving to M.I.T. through all channels, including the Alumni Fund, reached $24,541,090 in the year ending June 30. There were contributions from 213 companies matching the Alumni Fund gifts of their employees, a total of $117,273; and 136 parents of M.I.T. students gave $7,722 to the Parents Fund.

Record pledges of $4,710 came to the Alumni Fund from members of the Class of 1971; Stuart A. Marson as Campaign Chairman led the drive for the Kent State Memorial, an annual debate or lecture on the problems of the day to be given at the Institute as a tribute to the four students killed in Kent, Ohio.

The Class of 1938—Frank B. Kemp, Class Agent—made the largest contributions (excluding those reported by reunion classes) to the 1971 Alumni Fund—$191,762. Of classes graduated less than 25 years ago, the Class of 1948 (D. Dennis Allegretti, Class Agent) led with $52,-615. Five classes graduated from M.I.T. less than 20 years achieved Fund participation of 50 per cent or higher, the highest being the Class of 1959 (Richard L. Sampson, Class Agent) with 53 per cent. But the honor of highest Fund participation in 1971 was reserved for the old-timers: a tie between the Classes of 1907 and 1911, each with 70 per cent of its living members making gifts.

Alumni of the M.I.T. Graduate School made a significant contribution to the 1971 Alumni Fund; there were over 500 more donors in 1971 than in any previous year, and the Sloan Fellows alumni of the Sloan Fellowship Program in the Sloan School of Management achieved a participation of 58 per cent.

Tuition: First Annual Increase

Tuition at M.I.T. will increase by $250 to $2,900 per year beginning with the 1972 Summer Session. The 1972 increase, announced this summer, represents the first annual tuition increment, forecast by Howard W. Johnson, then President of the Institute, a year ago when he announced a $150 increase effective with the start of the 1971 Summer Session.

President Jerome B. Wiesner, announcing the 1972 tuition increase in a letter to parents, noted the Institute's increasing costs for both supplies and salaries. "Determined as we are to maintain the quality of an M.I.T. education," he wrote, "our only prudent course is to concentrate on minimizing costs and to adjust tuition as necessary to maintain its proportionate contribution to the overall educational budget."

Expenses at M.I.T. have exceeded income by some $2 million a year for each of the past two fiscal years, and a similar shortfall is expected—despite economies —in the 1971-72 year. Dr. Wiesner assured parents that "intensive efforts are being made to develop the Institute's other sources of income," but he wrote that these efforts, even as successful, "cannot cover that share of the cost of education borne by tuition.

"It continues to be our desire that no qualified student should be prevented from coming to M.I.T. for lack of financial resources," Dr. Wiesner wrote, and he assured parents that the Institute is "examining every alternative" to attain this goal—including new loan programs as well as intensive fund-raising efforts for M.I.T. scholarship and loan funds. And he held out the hope that improved forms of federal aid to higher education may soon be available to reduce the direct burden on tuition.

Freeze Barely Felt: Everything Was Already Up

President Nixon's Executive Order freezing prices, rents, wages, and salaries caused a bit of initial confusion at M.I.T., but due to an accident of timing its overall impact has not been great. The tuition and fees increase had already taken effect at the beginning of the Summer Session, and no general salary increases were scheduled to take place during the 90-day period covered by the order.

Nevertheless, a number of special problems had to be resolved through interpretations of the Cost of Living Council guidelines. As this issue goes to press, decisions have been made, but "there is always the possibility that a new ruling from Washington could change the guidelines," said John M. Wynne, Vice President for Administration and Personnel.

Some of the main points of M.I.T.'s response to the order are:

The increase in tuition to $2,650, announced a year ago, stands. "Since increases in tuition, room and board, and medical fees were announced before August 14 and meet certain other conditions stipulated by the Cost of Living Council, the freeze is not applicable to them," Mr. Wynne believes. The tuition increase to $2,900 (*see above*) announced August 9, is not scheduled to go into effect until summer 1972.

Student financial aid is not affected by the freeze, but the two-year trend of declining scholarship funds continues.

Leonard V. Gallagher, '54, Associate Director of Student Financial Aid, reports that every student's need is still being met, but through an increasing proportion of funds from loans and from part-time employment.

Students who returned to their old part-time jobs after being away for the summer were effectively newly hired and were able to receive higher pay than they did last year. Still uncertain at press time was the effect on about 150 students who kept their jobs during the summer.

Although dormitory rents went up as scheduled, rents in Eastgate and Westgate married student apartments are frozen. "They do not meet the same conditions as room and board set forth in Federal rulings," Mr. Wynne noted, but they will most likely go up when the freeze ends.

Research Assistants and Teaching Assistants are receiving the higher wages that went into effect at the beginning of Summer Session, when tuition and fees went up. Those who were newly appointed at the beginning of the fall term get the same rates as those who received increases last summer. Mr. Wynne reported that about 700 Research Assistants and 70 Teaching Assistants were working during the month of July on the new pay scales. "Until we're reversed," Mr. Wynne added, "we're standing on the new scales."

At press time, most of the problems raised by the freeze had been resolved and M.I.T. could consider itself lucky for the timing of the order. No one was willing to say, however, what would happen if the freeze were extended well beyond the November 15 termination date. The next wage and salary reviews, those for the hundreds of laboratory and research staff members, are scheduled for January 1.

Departments of Philosophy and Ocean Engineering

Two new names appeared in the list of academic departments when M.I.T. published the 1971-72 General Catalogue late this summer:

☐ The Philosophy Section in the Department of Humanities has become the Department of Philosophy in the School of Humanities and Social Studies.

☐ The Department of Naval Architecture and Marine Engineering has become the Department of Ocean Engineering.

Creation of the Department of Philosophy—of which Richard L. Cartwright, Professor of Philosophy who headed the Philosophy Section, was named head—was approved by the M.I.T. Corporation in June. The faculty had earlier agreed to the new status for the Section and had approved an undergraduate program leading to the degree of bachelor of science in philosophy, effective this fall.

Professor Cartwright says the Department's objectives are to specialize in branches of knowledge in which M.I.T. is now and will remain strong. He promises a program "whose center of gravity lies squarely in the general areas of analytical philosophy; the philosophy of science; logic; and the foundations of mathematics, linguistics, and psychology.

"It is only fair to say that our Department appears unbalanced when compared with more typical programs. However, we think such a program in philosophy at M.I.T. properly reflects its location in an institute of science and technology," he wrote.

The Philosophy Section had a faculty of 16 and ordered undergraduate and graduate courses to a total of more than 800 students a year, and Professor Cartwright expects the size and scope of the new Department to remain "about the same."

The change in name for the Department of Ocean Engineering recognizes the increasing interest among students and faculty in the broad areas of ocean utilization and ocean environment. There will be no diminishing interest in the traditional fields of ship design and construction and marine power engineering, according to Alfred H. Keil, Dean of the School of Engineering who formerly headed the Department of Naval Architecture and Marine Engineering. "Rather, the Department's long-standing expertise in marine vehicles and selected engineering sciences forms a solid foundation upon which to build [work on] . . . all man-made systems relating to the oceans," Dean Keil's statement said.

The Department first offered an ocean engineering curriculum in September, 1967; since then the development of the offshore oil industry and increasing emphasis on ocean exploration and utilization of marine resources have provided additional stimulus, Dean Keil wrote.

The New Honorary Chairman Foresees a New Future for Science

When he visited with James R. Killian, Jr., '26, this summer—just after Dr. Killian had retired as Chairman of the M.I.T. Corporation—Alton L. Blakeslee, Science Editor of Associated Press, found Dr. Killian foreseeing "a trend toward greater public and governmental acceptance of the concept that more science, more engineering, more technology —not less of them—are essential to solving societal, economic, and human problems."

It was only a week earlier that Dr. Killian had been designated Honorary Chairman of the M.I.T. Corporation, a title in which he succeeds Vannevar Bush, '16. At the same time, it was announced that Dr. Killian will continue—despite his retirement as Chairman of the Corporation—"to participate fully in the affairs of the Institute he has served for nearly half a century." *(For a record of that service, see "The Killian Years and M.I.T.," by George R. Harrison in* Technology Review *for July/August, pp. 16-16H.)*

Officially, Dr. Killian will remain as a Life Member of the Corporation—as well as its Honorary Chairman—and will be Chairman of its 150-member Development Committee; he has been active at the Institute throughout the summer, perhaps more visible (at the Faculty Club and elsewhere) than formerly because of a lightened appointment schedule.

Recalling for Mr. Blakeslee the post-Sputnik months of 1957 when there was worry that the U.S. might be losing its technological leadership, Dr. Killian said, "The great strength of that period was that a group of scientists and engineers were doing their best, out of the limelight, to serve the President and their country, with no commitment to a political party.

"It was a time when science had the confidence of the people. And Eisenhower had the confidence in us." Later, in an interview with Robert Reinhold of the *New York Times,* Dr. Killian is quoted as saying that President Eisenhower—for whom Dr. Killian was the pioneer White House Science Adviser—"was very responsive to innovative ideas—he has never been credited for that. He enjoyed meeting with scientists," Dr. Killian said.

In contrast, Dr. Killian said, "I don't think science was ever high on President Lyndon Johnson's agenda. . . . There was a lessening of influence and impact of science in his administration—not so much by conscious design, more a turning away."

Despite popular disinterest in science and technology in very recent years, Dr. Killian told Mr. Blakeslee that he sees science as "a fundamental force in the human intellect and culture; it has a majesty of research and discovery; it represents some of the highest achievements of the human mind.

"We are not going to give all that up."

Orchestrating M.I.T.'s Concern For the Consequences of Technology

His is "the most exciting job in the U.S., because M.I.T. is the most exciting place," Jerome B. Wiesner, President of the Institute, told the Alumni Leadership Meeting of the M.I.T. Alumni Center of New York this summer.

Though M.I.T. has always had a major role in the development of our society, Dr. Wiesner said, we now must understand that the nature of that role—if not its significance—is changing. The world now faces new issues, wrestling with "the opportunities we have created for ourselves," Dr. Wiesner said, and the Institute has "an almost unparalleled opportunity" to be a "symbol of rationalism in the use of technology."

Putting these issues in local terms, Dr. Wiesner noted that M.I.T. students have not yet resolved "their basic unhappiness with the state of the world or their uncertainty about their role in it." But violence is no longer a likely response, President Wiesner said, because increasing numbers of students are seeking a constructive part in solving the world problems they perceive. Hence, he said, the markedly increased interest in such fields as law, education, and medicine.

Instead of interests in "high" technology, said Dr. Wiesner, many students now demonstrate a concern for the economic, social, and human aspects of what engineering can accomplish. Thus, he said, M.I.T. must seek "a new orchestration of our capabilities" to concentrate on the social impact of scientific and engineering developments. Yet, he said, "understanding of the universe also remains a central issue for the rational

Over 6,000 active M.I.T. alumni (14 per cent of the national total) live in the New York City area, and 25 per cent of the Class of 1975 has come from there. There were 33 alumni meetings in the area in 1970-71, for which there were 5,000 registrations. Can the Alumni Center of New York do even better in its support of M.I.T. in 1971-72? was the question from Daniel I. Cooper, '46, Vice President of McGraw Hill Publishing Co., at the Center's Alumni Leadership Meeting on June 30.

man."

Discussing alumni relationships, Dr. Wiesner proposed to members of the Alumni Center of New York that the Institute must seek "more meaningful communication" between the Institute and its graduates, using new technology wherever it can be effective. And he hopes, he said, that new studies of the educational process to be undertaken in Cambridge will show how the discontinuities between undergraduate, graduate, and continuing education can be decreased, bringing alumni into a single, continuing relationship with the Institute which can be seen as beginning with their entrance as freshmen.

Earlier in the late-afternoon meeting, six members of the Board of Governors of the M.I.T. Alumni Center of New York had spoken briefly of their ambitions for the center's programs in support of the Institute during the 1971-72 year. Daniel I. Cooper, '46, suggested the importance of continuing education as a means for M.I.T. to have a greater role in the New York area as well as for alumni to feel an increasing involvement with the Institute. Po-Chiu Mar, '65, cited four areas in which to develop greater alumni involvement in the Center: career development, improved communications, long-range planning for alumni programs, and increasing financial resources. And Arnold F. Kossar, '51, suggested the importance of a more aggressive effort—by the Institute, by Educational Counselors, and by the Center—to create a better understanding of M.I.T. among alumni and such special groups as high school students and business leaders.

Thomas J. Crane, 1908-1971

Thomas J. Crane, Fiscal Officer for the Division of Sponsored Research, died on July 20; he was 63.

Mr. Crane came to M.I.T. in 1953 to serve with the Division of Industrial Cooperation (now the D.S.R.) and the Research Fiscal Office. He was named as D.S.R. Fiscal Officer in 1961. Graduated from Boston College and the Harvard Business School, Mr. Crane had served in both World War II and the Korean war.

A Digest of New Academic and Administration Appointments

Ten major appointments to administrative and teaching activities of M.I.T. for 1971-72 have been announced during the summer:

☐ Dr. Franklin D. Aldrich, Chief Resident at Lemuel Shattuck Hospital, to be Physician in Charge of the Environmental Medical Service.

☐ Frans A. S. Alting von Geusau of the University of Tilburg, The Netherlands, to be Visiting Professor in the Department of Political Science for 1971-72.

☐ Mrs. Dorothy L. Bowie, Assistant to the Dean for Student Affairs, to be Assistant Director of Financial Aid.

☐ James D. Bruce, Sc.D.'64, Associate Professor of Electrical Engineering, to be Associate Dean of the M.I.T. School of Engineering.

☐ Emilio Q. Daddario, former member of the U.S. House of Representatives who is now Senior Vice-President of Gulf and Western Precision Engineering Co., to be Visiting Lecturer in Political Science during the fall term.

☐ Brig. Gen. Robert A. Duffy (Ret.), formerly Vice Commander of the Air Force Space and Missile Systems Organization, to be Vice President of the Charles Stark Draper Laboratory Division.

☐ Bernard J. Frieden, Ph.D.'62, Professor of City Planning at M.I.T., to be Director of the Joint Center for Urban Studies of Harvard and M.I.T.

☐ Louis Guttman, Director of the Israel Institute of Applied Social Research, to be Visiting Professor of Political Science for 1971-72.

☐ Jon Hartshorne, formerly Director of International Student Services at Texas Technological College, to be Assistant to the Dean for Student Affairs.

☐ Kasha Linville, artist and critic of New York and Washington, D.C., to be Director of Exhibitions.

☐ Constantine B. Simonides, formerly Vice-President and Assistant to the President, to be Vice-President in the Office of the President and Chancellor.

Brief notes about each appointment and its appointee follow:

Dr. Aldrich succeeds Dr. Harriet L. Hardy, who retired on July 1; work in plant physiology and toxicology following study at Oregon State University; M.D. (1962) Western Reserve; Assistant Professor of Preventive Medicine, University of Colorado, and later Director of the Colorado Community Study on Pesticides, 1963-69.

Dr. Alting von Geusau is Director of the John F. Kennedy Institute in the University of Tilburg's Center for International Studies; he is an expert in international law and Chairman of the Working Group on Science, Technology and Public Policy of the University.

Mrs. Bowie, formerly in the Department of Metallurgy, has been associated with the Dean's office since 1964, first in connection with the foreign study adviser and later with services to women students.

Professor Bruce succeeds Charles L. Miller, '51, who will devote full time to his continuing position as Director of the Urban Systems Laboratory; joined the M.I.T. faculty upon completing doctoral studies in 1964; increasing administrative responsibilities in the Department since 1966 and Executive Officer since 1970, including development of on-line computer systems for managing academic resources; research in digital signal processing; 1969 Television Shares Management Corporation Award for teaching.

Mr. Daddario was a member of the House Committee on Science and Astronautics and Chairman of its Subcommittee on Science, Research, and Development while a member of Congress, 1958-70; a leading contributor to U.S. science policy; author of "Technology and the Democratic Process," *Technology Review* for July/August, pp. 18-23.

General Duffy was a special student at M.I.T. in 1952-53, working with Charles S. Draper, '26, Director of the Draper Laboratory; later assigned to the Guidance and Control Directorate of the Air Force Ballistic Missile Division, Office of the Director of Defense Research and Engineering, and Space and Missile Systems Organization. Retired from active duty July 31, 1971.

Professor Frieden was one of the first Fellows of the Joint Center as a graduate student in 1960; joined the M.I.T. faculty in 1961; research on rebuilding inner cities, government strategies for urban growth, and problems of urban poverty and inequality; consultant to government and private planning groups.

Dr. Guttman is a pioneer in the statistical and analytical aspects of social science research; his name is given to the Guttman scaling process, a mathematical method of ordering nonmetric data.

Mr. Hartshorne left his previous post when arthritis disabled him at age 28. Now recovered, he has spent two years overseas; graduate of Lawrence University and Yale Divinity School.

Miss Linville has been associated with

J. D. Bruce

R. A. Duffy

B. J. Frieden

J. Hartshorne

C. B. Simonides

W. A. Rosenblith

the Printmaking Workshop and Department of Cultural Affairs in New York, the Corcoran Biennial, and the Washington Gallery of Modern Art; has written on modern art for *Artforum, Arts Magazine,* and *Art News;* will be in charge of organizing exhibitions in the Hayden Galley and maintenance of M.I.T.'s art collection.

As Vice-President, Mr. Simonides will be the senior staff officer reporting to the President and Chancellor; responsible for studies of academic programs and operations, coordination and agenda development for academic councils and committees, and administrative supervision of Institute Information Services and the M.I.T. Press; Secretary of the Executive Committee of the Corporation. First became M.I.T. Vice-President in 1970, after administrative work for Summer Session, for Sloan School of Management, and as Assistant to the President (1966-70).

Rosenblith Is Provost

Walter A. Rosenblith, a distinguished biophysicist who has been M.I.T.'s Associate Provost since 1969, has been named Provost, succeeding Jerome B. Wiesner, now President of the Institute.

In his announcement, President Wiesner said the Provost will have Institute-wide responsibilities for educational programs with particular emphasis on interdepartmental, interschool, and interdisciplinary activities, laboratories, and centers. Thus Professor Rosenblith will be concerned with growing M.I.T. involvement in such areas as health sciences, urban and environmental programs, the interaction of science and technology with public policy, and international issues.

With President Wiesner and Paul E. Gray, '54, Chancellor, Professor Rosenblith will be among the senior academic officers of the Institute.

A native of Vienna, Professor Rosenblith began his career in biophysics with degrees in communications engineering from the University of Bordeaux and the Ecole Superieure d'Electricite in Paris; he first came to the U.S. in 1939 and for four years served in the Department of Physics at the South Dakota School of Mines and Technology. At M.I.T. since 1951, Professor Rosenblith has developed an extensive program of biophysics research and has more recently become increasingly involved with broad social applications of technology to health and urban problems. He was Chairman of the Faculty from 1967 to 1969, and he has had a distinguished career of service to committees and boards of the President's Science Advisory Committee and the National Academy of Sciences.

From Urban Studies to Housing

The appointment of a new Director for the Joint Center for Urban Studies of Harvard and M.I.T. (*see above*) was accompanied by a statement redefining the Center's emphasis and goals: the field of housing has been selected for special research attention in the 1970's.

Explaining this decision, Bernard J. Frieden, the Center's new Director, told Margo Miller of the *Boston Globe* that "housing is a pretty acute problem in the U.S.," and incentives for innovation in the field have been considerably improved by government subsidies included in the 1968 housing act. Indeed, he said, a number of companies interested in the field of housing have assured the Center of financial support for programs to study the real needs for housing in the U.S., what customers for new housing want in relation to what the industry is now providing, and how these expressed needs can be met through planning and technology.

"We don't want to have just housing experts looking at housing—but urban experts," Professor Frieden later explained to Jack Rosenthal of the *New York Times.* "For example, it is important to know what sociologists can tell us about how residents react to living in new towns."

The new focus on housing is the result of an evaluation of the Center's past and future service in which its Visiting Committee was joined by representatives of faculties and administrations of both Harvard and M.I.T. The group, chaired by Andrew Heiskell, Chairman of the Board of Time, Inc., hoped to establish a mission that would continue to draw on the complementary talents of both Harvard and M.I.T., that would be a good subject for scholarly research, and that would provide for constructive feedback from the real world. Housing was seen to fit all three of these criteria.

The Center was originally established between the two institutions in 1959; its mission then was to encourage urban-related teaching and research at both universities, and it did this, in part, by providing research opportunities to faculty and students in subjects such as the history of cities, urban economics, transportation, ethnic groups, urban renewal, and police behavior.

Now that job is done, says Professor Frieden: the two universities offer some 100 courses relating to problems of the cities, and these have spawned many research opportunities.

Registering the 18-21 Vote: When Is a Student a Resident?

By Joseph L. Kashi. '72

Will newly enfranchised 18- to 20-year-old M.I.T. and Harvard students tip the Cambridge political balance leftward? Perhaps—but not until they can become registered city voters over what has seemed to be intense opposition from some Cambridge residents and many politicians. Of 18,000 potential student-voters in Cambridge, only a few of the small minority present in Cambridge in the summer had been able to register. In all, by September 1, Cambridge had registered 3,211 18- to 20-year-olds, but most were young people living with their parents or working in Cambridge.

As of September 1, the Cambridge election Commission was refusing to register any student unless he could prove that he had resided in nonuniversity housing for six months and was completely self-supporting. Students able to furnish this proof were registered—but occasionally found themselves harassed by long waits and unnecessary red tape.

Despite a strongly registered opinion by Massachusetts Attorney General Robert Quinn that dormitory residents were entitled to vote in the communities in which they attend school, the Cambridge Election Commission estimates that it has registered only 20 to 25 such students, and in each case the new voter was accepted only after he appeared before the full Election Committee.

Finally, as this issue of the *Review* went to press, the Civil Liberties Union of Massachusetts took up the students' cause, petitioning in federal court in behalf of four students, including Daniel Greer, '72, and Arlene Fingeret, '72, of M.I.T. But legal proceedings seemed likely to extend beyond the registration deadline for the November 2 city elections.

Early in September Mrs. Jane Goodwin, Director of the Cambridge Committee on Voter Registration, said that Cambridge was "probably the most difficult city in the Commonwealth to register in." Her group has been conducting an intensive campaign to register the estimated 31,000 potential voters under 35, while warning them to be prepared for a "difficult and unpleasant experience."

Anticipating massive student registration in Cambridge, both traditional city and activist groups have been scrambling to organize. Many permanent residents feel that students, who generally don't pay taxes, should not vote because they do not have a long-term interest in the community. Others are fearful that recently controversial issues such as rent

control and police-community relations may again flare, aligning student-backed candidates against those preferred by many older residents.

Late in August the American Civil Liberties Union and four students brought suit against the city to force registration of all qualified young voters; the case is pending as this issue goes to press.

Cambridge's unique preferential balloting system accentuates the influence of 18,000 young people in elections where 30,000 to 35,000 voters normally turn out. Voters list candidates on their ballots in order of preference. The number of vacant City Council or School Board positions is then divided into the number of votes cast, giving the number of first-choice votes a candidate must receive to win. Anyone exceeding this number on the first count is elected; a second count is made after the first-count winners are eliminated to fill remaining vacancies.

Mrs. Goodwin estimates that if all eligible students were registered, they would routinely control at least three of the nine positions on the City Council. Adding their votes to those of non student young voters and older voters of liberal sentiment, newly enfranchised students could easily change the tone of city politics, making the government of Mayor Alfred Velluci, often at odds with the universities and their students, very vulnerable.

Ellsberg: Still at Work

Daniel Ellsberg, who has pleaded innocent to charges that he illegally possessed classified papers relating to the origin and development of the Vietnam war, will stand trial in Los Angeles, Calif., beginning on January 4, 1972. Meanwhile, in keeping with M.I.T.'s long-standing policy of taking no action which implies a position on court actions, the Institute's Center for International Studies has continued Dr. Ellsberg's half-time appointment as Senior Research Associate.

He is studying—and writing a book on—current American foreign policy decision-making in times of crisis; no teaching duties are included in Dr. Ellsberg's assignment.

Meanwhile, in many public statements during the summer, Dr. Ellsberg has been emphasizing that the "Pentagon papers" thus far published in the *New York Times* and elsewhere represent only "a tiny fraction" of the official reports about Vietnam. "The American public should have all these papers and doesn't have them yet," he said at a press conference early in August.

Subsequently it was revealed in Cambridge that both the Harvard and M.I.T. university presses had been offered substantially the full—presumably—47 volumes of "Pentagon papers," and both declined to publish them. The source of the offer was never revealed at M.I.T., and the M.I.T. Press insisted that Dr. Ellsberg himself was not involved.

According to the *Boston Globe*, Mark Carroll, Director of the Harvard University Press, said Harvard would find the task of publication "beyond our reach." The M.I.T. Press declined the manuscript after consultations with its Editorial Board and M.I.T.'s attorneys, according to Robert M. Byers, Director of the M.I.T. News Office.

Ocean Policy and Management

A new program in marine policy and ocean management has been inaugurated this fall at the Woods Hole Oceanographic Institution, in cooperation with M.I.T., Harvard, and the Fletcher School of Law and Diplomacy at Tufts University. Paul M. Fye, President of W.H.O.I., said the goal is to "stimulate the cooperative investigations of marine policy issues by both marine and social scientists."

A $200,000 Ford Foundation grant in connection with the program will make possible fellowships from W.H.O.I. to doctoral students for work in marine-related aspects of such fields as political science, economics, international law, diplomacy, management, and decision theory.

Tennis—and an Ill Wind

The J. B. Carr Indoor Tennis Center, an air-supported, inflatable structure, rose on schedule late this summer, but the fates—or the elements—were against its remaining up very long. Just two days after the dome's ceremonial inflation on August 26, winds from a tropical storm called Doria caused a structural failure in the dome and brought it down. Repairs to the fabric were completed by its makers, Birdair Structures Co., in less than three weeks, and four indoor tennis courts became a reality at M.I.T. early in October.

Walter Bird, '34, whose company built the dome, explained the Doria failure this way: Because the dome had been so recently installed, it had not yet had time to stretch out to its final and aerodynamically correct shape. The severe winds caused stress concentrations to build up and initiated the tear. Students who witnessed the dome's demise described it as a spectacular sight.

Jasper B. Carr, '16, had been on hand to personally dedicate the dome which bears his name. After he threw the switch to activate the air pumps, the dome rose slowly to its 40-foot height—covering a ground area large enough to contain four tennis courts.

New Hospitality

The M.I.T. Infirmary, long an incongruous appendage to the main buildings of M.I.T., now has a home of its own in the center of the Institute's residential campus.

Alterations were completed late last summer for the Infirmary to occupy the building adjoining Baker House used for many years as the Sancta Maria Hospital. The result is more and better space for patients—and equally more and better space for the Medical Department's clinical and out-patient activities which remain in the main buildings.

The new infirmary building provides

Jasper B. Carr, '16 (left), starts the compressors to inflate M.I.T.'s new Indoor Tennis Center (above). Just two days later, however, strong winds caused the fabric structure to tear and collapse. Now repaired, the dome provides four indoor tennis courts on the west campus.

Moved from the main buildings to quarters formerly used by the Sanota Maria Hospital on Memorial Drive, the M.I.T. Infirmary now provides more nearly all the "comforts" of home. There is more and better space for patients—but less convenience for staff members who want to see their students while sick (which may be a subtler advantage of the change?).

space for 28 patients, a significant increase in capacity, in both private and semi-private rooms. Arrangements provide considerably greater flexibility in accommodating women students and student wives. In addition, the first floor contains a new dental clinic providing—for the first time at M.I.T.—comprehensive dental care for students and their wives, a small operating room, and doctors' offices and examining rooms.

Meals for infirmary residents come across the street from McCormick Hall on weekdays and across the plaza from the Student Center on weekends. A small kitchen with a microwave oven is provided for emergencies—and for special needs.

Launching the first balloon from the National Weather Service's new Environmental Meteorological Support Unit atop Building 24 at M.I.T.: (left to right) Oscar Tenenbaum, Meteorologist in Charge at the National Weather Service's Logan Airport station; Henry Cochran, in charge of the station at M.I.T.; Carl Johannessen, Associate Director of the National Weather Service; and Norman A. Phillips, Head of the M.I.T. Department of Meteorology, the presence of which was a factor in the Service's decision to locate the Unit at the Institute. (Photo: Margo Foote from Tech Talk)

Pollution Monitor

U.S. National Weather Service balloons instrumented to help determine the potential for air pollution over Greater Boston are now being launched daily from an Environmental Meteorological Support Unit atop M.I.T.'s Building 24.

As the balloons rise slowly to heights of about 10,000 feet, the instrument packages they carry measure—and transmit to earth—data on temperature, air pressure, and humidity; the wind they encounter is determined by optical tracking. These four are the principal conditions which affect the dissipation of smoke and other urban atmospheric pollutants, and so the data will serve to indicate probable pollution levels.

When the balloons reach 10,000 feet altitude their instrument packages are cut away to float back to earth on paper parachutes—and perhaps to be recovered for reuse.

Accelerometer on the Subway

Pencil and paper, chalk and blackboard are the usual ways of teaching differentials and integrals to college freshmen. If the resulting abstractions of rates and summations are sometimes hard to understand, try instead the "calculus laboratory" developed by and for a group of students in M.I.T.'s Unified Science Study Program (*see* Technology Review *for December, 1969, page 90*).

With the help of William U. Walton and Harry M. Schey of the Education Research Center, the students built a simple accelerometer—a U-shaped tube filled with a bubble in it. The bubble moves as the tube is accelerated, and the movement of the bubble is calibrated in miles per hour per second in a device which tilts so that an appropriate fraction of the earth's gravitational field pulls along the tube.

After building and calibrating their accelerometer in this way, three students took it for a subway ride from Kendall to Harvard Square last summer, making measurements of acceleration and deceleration versus time. When they returned to U.S.S.P. headquarters, they integrated the acceleration curve numerically to find the velocity as a function of time—and found that the top speed between both stations was "a very reasonable" 45 to 46 m.p.h. Then they integrated velocity with respect to time to obtain position as a function of time—and eventually determined from their data that the distance from Kendall to Central Squares is 0.93 mile, from Central to Harvard 0.98. On the map the two distances are 1.04 and 0.95; the total—1.91 miles measured, 1.99 on the map—shows a discrepancy of only 4 per cent.

Conclusion: the accelerometer is "a remarkably accurate" instrument.

It's also remarkably inexpensive—about 30 cents. "So the main cost of the experiment is the subway fares," says Mr. Schey.

Alumni Calendar

Atlanta—October 4, Monday, 12:00 noon —Riviera Restaurant, Peachtree Street.

Boston—October 14, Thursday, 12:15 p.m.—Luncheon meeting, Aquarium Restaurant. Speaker: Robert T. Kenney, Director of Boston Redevelopment Authority. Topic: "Redevelopment: What's Happening in Boston."

—November 11, Thursday, 12:15 p.m.—Luncheon meeting, Aquarium Restaurant. Speaker Alfred H. Keil, Dean of School of Engineering. Topic: "The Education of an Engineer at M.I.T."

—December 9, Thursday, 12:15 p.m.—Luncheon meeting, Aquarium Restaurant. Speaker: J. Herbert Holloman, '40. Topic: "Technology and Society: America's Dilemma."

Cambridge—October 7, Thursday, 4:30 p.m.—Rockwell Cage. Inauguration of Dr. Jerome B. Wiesner as 13th President of M.I.T. and Dr. Paul E. Gray, '54, as Chancellor of M.I.T. Reception following, Rockwell Cage.

—October 8, Friday, 11:00 a.m. to 2:30 p.m.—Alumni Club Advisory Board meeting.—Mezzanine lounge, Student Center.

Dedham—October 17, Sunday, 12:00 noon.—Endicott House. Luncheon honoring Dr. Jerome B. Wiesner, by Class of 1918.

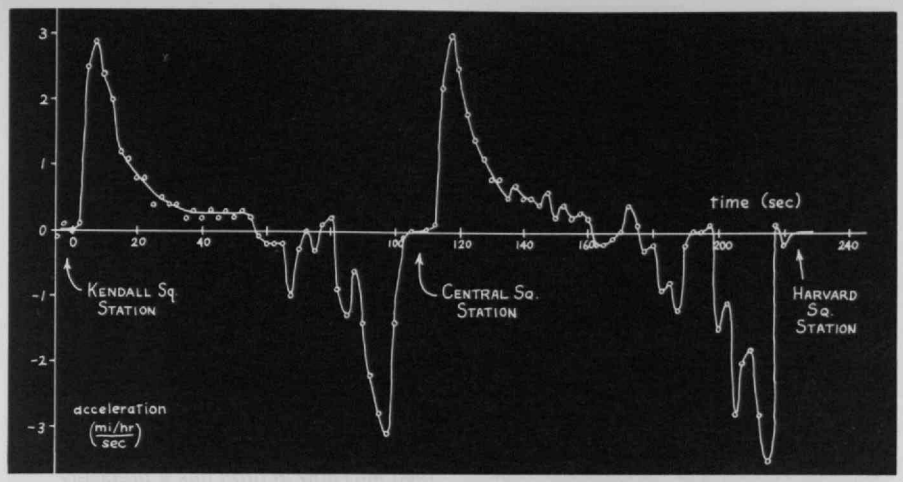
London—October 20, Wednesday.—Dinner meeting honoring John E. Burchard, '23, Dean Emeritus, School of Humanities and Social Studies.

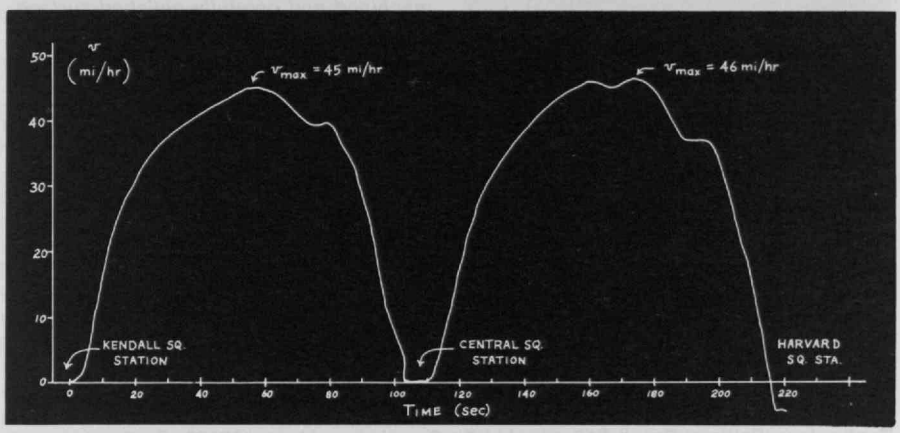
New York—November 4, Wednesday, 5:30 p.m—Cocktail party, Metropolitan Museum of Art.

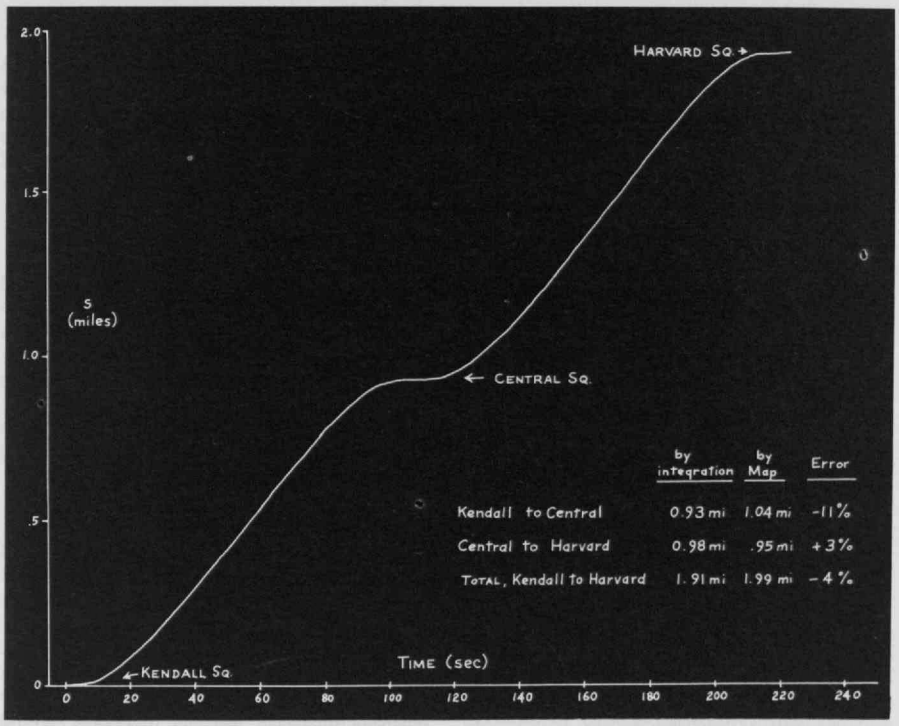
—October 20, Wednesday, 5:30 p.m.—M.I.T. Alumni Center of New York, M.I.T. Advanced Engineering Home Study Course Film Preview on Probability.

—November 17, Wednesday, 12:00 noon. —Luncheon meeting, Brass Rail Restaurant, 5th Avenue. Speaker: Howard J. Samuels, '41, President, Off-Track Betting Corporation.

Philadelphia—November 13, Saturday, 6:30 p.m.—Dinner meeting, Wilmington Country Club, Speaker: Harry G. Haskell,







"An accelerometer and a clock are the basic inputs for inertial guidance systems that enable a submarine to locate itself under the polar ice cap or a moon probe to know its position in space," writes William U. Walton of the Education Research Center. Mr. Walton and Harry M. Schey have devised a simple accelerometer to build from 30-cents-worth of materials, and three students have used it to find their way on the subway from Kendall to Harvard Squares. They measured the acceleration of their subway car (top), then integrated the acceleration data to learn its speed (middle), and finally integrated the velocity data to plot its location as a function of time below).

Jr., Mayor of Wilmington, Delaware.
Washington, D.C.—October 18, Monday, 6:30 p.m.—Dinner meeting, University Club. Speaker: Dr. Paul E. Gray, '54, Chancellor, M.I.T.
—October 6, Wednesday, 6:30 p.m.—Dinner meeting, Terrace Room, Prospect House, Arlington, Va.

Deceased

William E. Barbour, '96, June 27, 1971
Chandler Hovey, '02, July 27, 1971*
Robert Palmer, '04, February 4, 1970
Isadore J. Nye, '05, July 12, 1971*
Frederick C. Jaccard, '07, July 2, 1971
Edward L. Ryerson, '09, August 2, 1971
James G. Tripp, '10, July 26, 1971*
C. Phillips Kerr, '11, June 27, 1971*
E. Dana Pratt, '13, May 3, 1971
Ralph Hart, '15, July 20, 1971*
Marcel Gillis, '16, May 22, 1971*
Everett B. Johnson, '16, July 4, 1971
James W. Doon, '17, June 24, 1971*
George W. Oxley, '18, June 30, 1971
Clarence D. Hanscom, '18, May 4, 1971
Charles E. Little, '19, June 4, 1971
John E. Jackson, '22, April 3, 1971
Joseph P. Keegan, '23, July 31, 1971
Hillman M. Bishop, '25, July 28, 1971
Roland H. Turner, '25, March 3, 1971*
John Hoxie, '25, May 13, 1971*
L. Gray Marshall, '25, March 17, 1971
George J. Saliba, '27, July 6, 1971*
Benjamin F. Miller, '28, June 28, 1971
Rand B. Jones, '30, August 6, 1971
Leonard Johnston, '31, May 7, 1971
Lawrence G. Mohr, '31, March 1, 1969
David Motter, '31, n.d.
Ralph W. Crary, '32, June 18, 1971
Francis R. Duprey, '32, February 25, 1971*
Curtis D. Cummings, '32, January 15, 1971
John Griswold, '32, May 2, 1971
Howard A. Kinzer, '32, June 5, 1971
John W. Campbell, Jr., '33, July 11, 1971*
Chester Dodge, '33, June 27, 1971
Palmer E. Koenig, '35, August 3, 1971
Alden E. Tower, '35, September 12, 1970
Donaldson R. McMullin, '36, July 11, 1971
Robert N. Johnson, '44, June 18, 1971
Keith B. McCutcheon, '44, July 18, 1971
James E. McDonald, '45, June 13, 1971
Carlo Piazzo, '60, September 21, 1970
* Further information in Class Review

Lincoln Calibration Sphere II

A 44-inch polished aluminum sphere designed at the M.I.T. Lincoln Laboratory—the second Lincoln Calibration Sphere—is now in orbit, and both spheres are in use as standards for calibration of powerful radio and radar systems. The first LCS was launched in 1965 into a circular orbit at an altitude of 1,500 nautical miles. The new sphere is orbiting at an altitude of about 450 miles, making it more easily accessible and therefore more useful to a larger number of radar facilities.

In addition to aiding the accurate calibration of radar systems, the sphere will be useful in making direct measurements of the effects of different weather conditions on radio wave propagation and will provide additional information about the shape of the earth's gravitational field. By showing the effects of air drag on the orbital period, the new, lower-altitude sphere will also provide valuable information about atmospheric density and its variations.

Designed for direct measurement of the sensitivity of large radio and radar systems, the new Lincoln Calibration Sphere (see left) now in orbit has a precisely machined and carefully polished surface to produce steady radar echoes of uniform strength.

Talent Available

These announcements are published in *Technology Review* without cost for graduates of the Massachusetts Institute of Technology who have registered their interest in new professional opportunities with the Institute's Alumni Placement Office. Such alumni are invited to submit statements, not exceeding 50 words and including relevant details of field and date of degree, professional experience, and interests to the Editor, *Technology Review,* Room E19-430, M.I.T., Cambridge, Mass., 02139. Each announcement will be published in a single issue of the *Review;* subject to the availability of space, announcements received by August 25 will appear in the *Review* for September/October, 1971. The identity of advertisers will not be revealed either in print or in correspondence; respondents' letters, addressed to the appropriate key number at *Technology Review,* will be forwarded unopened to the advertiser.

Nuclear/Heat Transfer Engineer—B.S.(chemical engineering) '57 Purdue, S.M.'59 M.I.T. Eight years' experience in heat transfer design of nuclear reactor fuel elements, pressure vessels, heat exchangers, condensers, lines and valves; publications and patents. Previously refinery engineer. Salary and location open. Key ONO-1.

Nuclear-Atomic Physics—S.B.'62, Ph.D.'67, in experimental nuclear physics, minors in general physics and mathematical analysis. Research experience in gamma-ray and x-ray spectroscopy, nuclear structure; some teaching. Experienced with electrostatic accelerators, small computers, fast-timing electronics, and Fortran programming. Seeks challenging position with a future; will relocate. Key ONO-2.

Instrumentation and Logic—S.B.(electrical engineering)'67; age 26. Four years' experience in commercial and government instrumentation systems engineering and logic design, including light programming, engineering/customer/marketing liaison, technician supervision, and technical writing. Desire R & D work in photographic, biomedical electronics, or other interdisciplinary field. Strong interest in photography. Salary open. Location: Massachusetts preferred, then Midwest and West. Key ONO-3.

Materials Science—S.B.'53, S.M.'55 in electrical engineering. Fifteen years' experience in semiconductors, including design of instrumentation and controls, development of new techniques for crystal growth, management of materials preparation department in microwave industry, and five years' teaching in electrical engineering and materials. Interests in teaching, consulting on materials preparation and evaluation and solid-state devices. Key ONO–4.

Metallurgist/Materials Engineer—Sc.D. in metallurgy, '65. Four years' college teaching physical metallurgy and applications of materials. Experience in design and manufacturing processes. Research in alloy solidification and explosive fracture. Consulting work in failure analysis and troubleshooting. Seeking position in materials selection/design or research and development. Location open. Key ONO-5.

Manager, Injection Molding—S.B. in Mechanical Engineering, '50. Twenty years' experience in injection molding with key positions in production, engineering, and quality control. Currently in personnel administration specializing in training, management development programs, and safety. Desire responsible position in production management or industrial relations. Prefer Southeast. Key ONO-6.

Turbomachinery—S.B.'54, S.M.'55 in chemical engineering; Practice Station, Oak Ridge A.E.C. Plant. Turbomachinery design/development and pump design specialist. Four years' work in liquid metal pumps nuclear aircraft; ten years in chemical and nuclear rocket turbomachinery, managing up to 13 engineers. Desires project or specialist position with design responsibilities. Age 39. Key ONO-7.

Food Technologist or Representative—S.B. University of Zagreb (Yugoslavia)'63, food science and technology, M.I.T., '68. Experience: research (dehydration, flavor, juices, color), process planning and product development (fruit and vegetable products), teaching. Published several papers. Languages: English, Croatian (fluent), Russian (good), use German, Italian, French; Fortran IV. Seeks research, production, or quality control position in U.S.A. or as a European representative. Salary and location open. Key ONO-8.

Industrial Engineering/Management—S.B. in mechanical engineering '65 and industrial management '66. Five years' diversified experience including operations analysis, management consulting, manufacturing, product design and development, industrial and process engineering. Seeks challenging position, salary around $12,000. Location open. Key ONO-9.

Community Fellows

A new Community Fellows Program, patterned after M.I.T.'s successful back-to-school plans for managers (the Sloan Fellowship Program) and engineers (the Practicing Engineer Advanced Study Program), begins this fall in the Department of Urban Studies and Planning. It is made possible in part by a $400,000 grant of the Rockefeller Foundation.

Under the Program, 10 to 15 selected local leaders from minority communities throughout the U.S. will come to the Institute for one year of academic activities. They will work with M.I.T. faculty and staff on such problems as housing, health care delivery, job programs, educational systems, waste management technology, nutrition, and public service systems. The Fellows' program will include workshops on social and economic development and will involve faculty, staff, and students from throughout the Institute.

The goal is to prepare elected and other local community leaders to deal more effectively with technical, social, and economic problems that confront their communities. Jerome B. Wiesner, President of M.I.T., said in his announcement of the plans that the Institute "looks on this project as an important step in helping to meet the need for leadership in our urban centers with a wide variety of capacities from within the university."

The program was developed by Lloyd Rodwin, Head of the M.I.T. Department of Urban Studies and Planning, in response to the initiative of Melvin H. King, who for the past four years has been Executive Director of the New Urban League of Boston and who has now left that post to become Associate Director of the new M.I.T. Program. Frank S. Jones, Ford Professor of Urban Affairs in the Department of Civil Engineering and a member of the staff at the Urban Systems Laboratory, has been named Director of the Community Fellows Program.

Community Fellows will include members of the staffs of elected black officials, neighborhood housing corporations in ghetto areas, community development corporations, community action and model cities programs, civil rights organizations with community development components, and other similar organizations.

The Killian Award

A permanent award will be established by the M.I.T. faculty to honor James R. Killian, Jr., '26, who retired as Chairman of the M.I.T. Corporation after more than 40 years' service to the Institute on June 30.

The Killian Award will be made each year in recognition of "outstanding professional achievement" to a member of the M.I.T. faculty, who will receive an honorarium as the year's Killian Lecturer and will deliver one or more lectures on his work during the award year.

The Award, says the resolution of the M.I.T. faculty by which it was established, was created "as a reflection of Dr. Killian's consistent encouragement and support of professional excellence at the Institute, and as a token of affection and esteem for his long and brilliant service to M.I.T." Selection will be by a special committee of at least ten members, voted by the entire faculty from a slate prepared by the Nominating Committee.

Individuals Noteworthy

To J. Raphael Bates, Ph.D.'69, the 1971 Napier Shaw Memorial Prize, Royal Meteorological Society, London . . . to **Ernest R. Kaswell,** '39, the Olney Medal of the American Association of Textile Chemists and Colorists . . . to **Neal A. Lespasio,** '57, the U.S. Army's Bronze Star Medal . . . to **Holt Ashley,** Sc.D.'51, the Fiftieth Anniversary Medal, and to **Norman A. Phillips,** Head of the M.I.T. Department of Meteorology, the Carl-Gustaf Rossby Research Medal, both from the American Meteorological Society . . . to **Frank M. White,** S.M.'56, the Award for Excellence in Teaching, by the American Society for Engineering Education . . . to **Harry C. Wolf,** '60, the American Institute of Architects National Honor Award . . . to **Luis A. Ferré,** '24, the Life Quality Engineering Citation of the American Society of Mechanical Engineers . . . to **Carl C. Nelson,** S.M.'26, the Apollo Achievement Award, by N.A.S.A. . . . to **Harold V. Nutt,** '36, the U.S. Navy's Meritorious Civilian Service Award . . . to **Phillip G. Felleman,** '52, **Samuel Drake,** '65, **Lawrence J. Berman,** '55, **David H. Moore,** '68, **Allan R. Klumpp,** '55, Exceptional Service Commendations by M.I.T. for their work in the Apollo 14 Mission . . . **Thomas H. Pigford,** '48, **Louis H. Roddis,** S.M.'44, **Gerard de Saussaure,** Ph.D.'54, **Henry C. Honeck,** Sc.D.'59, to Fellows for the American Nuclear Society . . . **Robert L. Stern,** '48, to Fellow of American Institute of Chemists . . . to **Robert M. White,** Sc.D.'50, Honorary Degree, University of Chicago . . . **Joseph Levine,** Ph.D.'65, to Resident Research Associate, National Oceanic and Atmospheric Administration.

David K. Hardin, '49, to President-Elect, American Marketing Association . . . **Kenneth L. Block,** '47, to President, Institute of Management Consultants . . . Robert M. White, Sc.D.'50, to Administrator, National Oceanic and Atmospheric Administration . . . **Kenneth A. Roc,** '41, to President of American Society of Mechanical Engineers . . . **George A. Fowles,** '34, to Director-at-Large, Society of the Plastics Industry, Inc. . . . **Robert T. Dorsey,** '40, to Senior Vice-President, Illuminating Engineering Society, 1971 . . . **James M. Ham,** Sc.D.'52, to Chairman of the Committee on Education and Training of World Federation of Engineering Organizations . . . **Kent F. Hansen,** '53, to Director of the American Nuclear Society . . . **George A. Brown,** '51, to Director of Technologies Panels, Committee on Marine Systems.

Anthony G. Dempster, S.M.'64, to Babylon District Manager, Shell Oil Co. . . . **Henry W. Mertens,** '34, to Executive Vice-President and Manager, Division Operations, Central Maine Power Co. . . . **Frank T. Wheby,** '52, to Associate, Harza Engineering Co. . . . **W. H. Springer,** S.M.'68, to Vice-President and Comptroller, Illinois Bell Systems . . . **Carroll I. Johnson,** '50, to Vice-President, Friendly Ice Cream Corp. . . . **Richard H. Ewert,** '37, to President, American Gear Manufacturers Association . . . **Raymond R. Ambrogi,** '60, to Plant Manager, Science Products Division, Corning Glass Works . . . **David R. Chittick,** S.M.'69, to Director of Environmental Control, Western Electric . . . **Ralph L. Wentworth,** S.M.'48, to Vice-President, Dynatech R/D Co. . . . **Howard W. Johnson,** Chairman of the M.I.T. Corporation, to Corporation Vice-Chairman, Federated Department Stores, Inc. . . . **Philip B. Walker, Jr.,** '34, to President, Frank L. Adams Co., Inc. . . . **Jack Hilibrand,** Sc.D.'56, to Staff Engineer, Government Engineering, R.C.A. Government and Commercial Systems.

Charles G. Wing, Ph.D.'66, to Lecturer and Research Associate in Physics, Bowdoin College . . . **Francis N. LeBaron,** '44, to Chairman, Department of Biochemistry, University of New Mexico School of Medicine . . . **David C. Montgomery,** '60, to Registrar and Assistant Provost, Oberlin College . . . **Alan Altshuler,** M.I.T. Professor of Political Science, to Secretary of Transportation and Construction, Commonwealth of Massachusetts . . . **Gordon T. Gould, Jr.,** S.M.'50, to Lieutenant General and Director, Defense Communications Agency.

M.I.T. appointments: **Robert Ilfeld,** '44, to Associate Director for Executive Development Program . . . **Robert M. Hollister,** Ph.D.'71, to Assistant Professor, Urban Studies and Planning . . . **Robert S. Silver,** '63, to Visiting Professor, Mechanical Engineering . . . **Manuel Blum,** '59, to Visiting Associate Professor, Electrical Engineering . . . **K. Uno Ingard,** Ph.D.'50, to Professor of Physics and of Aeronautics and Astronautics . . . **Gerald L. Wilson,** '61, to Director, Electric Power Systems Engineering Laboratory and Associate Professor, Electrical Engineering . . . **Lawrence E. Susskind,** M.C.P.'70, to Assistant Professor, Urban Studies and Planning . . . **Charles A. Berg,** '56, to Associate Professor, Mechanical Engineering . . . **Leslie G. Bromwell,** '61, to Assistant Professor, Civil Engineering . . . **Joel E. Brown,** '59, to Associate Professor, Biology . . . **Roe W. Goodman,** Ph.D.'63, to Assistant Professor, Mathematics.

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Class Review

95

So glad I was able to attend the Class Secretaries meeting in June. Thanks to the *Review* staff for their many courtesies. A very special thank you to Mr. Ennis for wheeling me all over the place!

It was a pleasant surprise to receive a letter from James M. Barker '07, remembering our days together at Tech Club and his appreciation of my interest in a "young and callow fellow." Very kind of him to write this old-timer.

I received a letter from the Golden Rule Lodge, A.F. and A.M., Wakefield, Mass. which is as follows: "The Masonic Service Association, Washington, D.C., has published its 37th annual list of the oldest living Freemasons (in point of membership), and they have sent me a copy of the list to send you, for you are included in the list. You will note that you are number 26. Congratulations on being one of the 153 oldest living Freemasons —it's an honor of which you may justly be proud.—Allston Van Wagner, Secretary."

I became a Mason on December 12, 1895. It may be of interest to note that I am one of the ten oldest Freemasons from Massachusetts.—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

William E. Barbour of Berryville, Va., died on June 27 in the Winchester Memorial Hospital after a brief illness. He was born on April 1, 1874 in St. Charles, Illinois the son of Lyman Law and Helen (Minard) Barbour. He followed an older brother to M.I.T. where he enrolled in Course VI. In two years he learned that he was not destined to be an electrical engineer and left to go in business, starting as a clerk with Marshall Field, where he remained for only one year. He worked with other companies until 1902 when he set up his own organization of which he was president and treasurer until 1909. After four years with the Lincoln Fuel Co. he became manager of the Consumer Co. from which he retired in 1924.

Later, business interests led him to the middle Atlantic region and he retired to Berryville about ten years ago. In 1900 he married Mabel Ridgeway, who died in 1962. Mr. Barbour is survived by five children, Jane and Betty of Berryville, Harriette of Singapore, William E. Jr., '33 and Morton M. of Oceanside, Long Island, and by six grandchildren.—**Clare Driscoll,** Acting Secretary, Cliff St., Plymouth, Mass. 02360

98

It was good to be home during the summer "catching up" with family, friends and the house. We left Mexico on February 22 with our trailer and spent two and a half months traveling around the Gulf of Mexico, Florida and the southern states on the east coast. While en route north, I phoned **Bob Lacy** on April 29 in Baltimore, Md. We had a pleasant chat, mostly about his intention of going to Squirrel Island, Maine during the summer. I hope he carried out his plans—with much enjoyment. . . . In May I made my yearly Memorial Day visit to the town of Needham, Mass. As you know, **Joe Riley** lives there and I usually see him. He was as spry as ever, living alone in his charming house. The conversation centered around the islands from New Hampshire to New Brunswick! He suggested reading *The Island Cure* but I couldn't find it in the public library. I was happy to hear that his grandnephew returned from Vietnam and is selling insurance in Virginia.

Our sympathy goes to the family of **Lyman F. Hewins,** 95, who passed away on May 9, 1971 aboard his houseboat yacht in Fort Lauderdale, Fla. A native of Dorchester, Mass. he attended the schools there and graduated from M.I.T. in Course XIII, Naval Architecture. In the fall of 1898 he was appointed naval architect in the Navy Department's Bureau of Yards and Docks in Washington, D.C. On completion of an experimental model basin at the Washington Navy Yard in 1903, he became the basin's senior civilian naval architect. When he retired in 1943 from the David Taylor Model Basin at Carderock in Montgomery County, he had been in charge since 1920 of navy experimental work which had to do with ship forms, testing on designs, data as to depth bombs, torpedo defense nets and mine anchorage.

An avid yachtsman, he enjoyed his favorite diversion to the full upon retirement, living aboard his 55-foot craft for the past ten years, cruising from Massachusetts Bay to the Bahama Islands.

He is survived by a son, Commander Spencer F. of Leonardtown, Md., a daughter, Elizabeth H. Gallagher, of Fort Lauderdale, Fla., two grandsons, three granddaughters and seven great-grandchildren. Do you remember, as I do with pleasure, meeting his son and daughter-in-law and his daughter, Mrs. (Col.) Robert Gallagher in 1963 at the sixty-fifth reunion of '98?—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

99

To my classmates of '99. Your newsletters which you have been sending to the Alumni Office have not received publication in the *Review* and doubtless you have wondered why. The answer is that since the death of **Percy Witherell,** our faithful secretary, our Class has had no secretary and thus no publication of news. To get our class news in print again, your humble servant has offered himself as Acting Secretary for the Class.

We have received a letter from Mrs. Jean Wells Main, daughter of **Walter W. Wells,** saying that her father is in fairly good health at age 97.

Fred W. Grover writes that he so dislikes the winters in Schenectady, N.Y., that he has moved to Howard Gap Lodge, Lynn, N.C. 28750.

By invitation from **Carroll W. Brown,** your acting secretary called him this summer. He lives in a large comfortable colonial home about 250 years old located in his native town of Rye Beach, N.H. The homes surrounding his are, for the most part, large and well maintained with lawns and flowers. The town is a residential one and its streets are lined with tall shade trees. In short, Rye Beach is an outstanding old New England village of which Carroll is proud.

I received two letters from Carroll and from the second one I quote: "I enjoyed your visit very much and hope you can get to see me again before you have to leave for Florida. Everything is about the same with me. My eyesight is failing but I can get around the house nicely as I know where everything is located.

"The garden suffered from the fact that the weeds got ahead of the vegetables

Mr. and Mrs. Clarence M. Joyce, '03

and flowers. But we had some good from it, nevertheless. I hope that next year, I can get more and better help to take care of it. I also hope that you and Mrs. Seavey can get to York (Maine) again and get to see me more often and have less extremely hot weather than we had this summer. Except for my eyesight, my general health seems to be improving somewhat and I hope to be able to attend the alumni reunion next June. Remember me to all the '99 folks you may contact. My regards to Mrs. Seavey, Sincerely, Carroll W. Brown."

So now all the news you send to the Alumni Office will be forwarded to me so I can edit it for publication. These are the rules for *Review* publication. So please send in your news to the office or to me. **—Norman E. Seavey,** Acting Secretary, Apt. 514, Lucerne Towers, 20 West Lucerne Circle, Orlando, Fla. 32801

02

A letter received from **Carlton B. Allen** last June reports that he is in good health and still taking long walks. His son, Brig, '29, has retired and lives in Orlando, and his daughter, Peg, is in Switzerland for part of the summer. He was expecting a visit from his grandson and two great-grandsons.

Arthur L. Collier and his wife represented our class at the recent Alumni Day celebration in Cambridge. They have been very regular in their attendance and have kept our class on the "present" list. Arthur said they expected to take their usual vacation in Maine this summer. . . . **Ambrose Bourneuf** is still living alone in Melrose and is in good health. He has lived in Melrose 60 years and enjoys the city and his fine neighborhood. He has five children; all are well and active.

Chandler Hovey who was with us in our freshman year died in Brookline July 27, 1971. He was associated in the banking business with Kidder, Peabody, and Co. for many years; was very prominent in yachting circles and contended for the right to defend the America's Cup six times.—**Burton G. Philbrick,** Secretary, Greycroft Inn, 68 Dane St., Beverly, Ma.

03

Well, happy and carefree engineers of primeval days, relax and muse the antics of our loyal group of classmates. I was of course not overjoyed on Alumni Day, in viewing the list of Alumni to be present. There was an absence again of '03 classmates to enjoy the customary interesting day's programme. However, my gloom was soon abated, by our neighboring Class Secretaries who also met the same dilemma. With such an array of engineering excellence we soon assembled at a single table, prominently marked by our collection of class numbers. It also provided us with the long desired meeting, to share our arduous yet loyal duty as Class Secretary and enliven the interest of our pensive group. The entire program was much enjoyed by the immense throng that occupied the Cage, with stirring remarks from our devoted Dr. Killian and retiring President, Dr. Johnson.

An interesting letter received from our active classmate, **Clarence M. Joyce,** relates that his desired picture was awaiting an attractive background. The attached photo shows the pine woods in the mountains of Palm Springs, California. The house has been his domicile since 1952. He now enjoys his swim in the pool and daily musical entertainment with the School of Music and Art, called "Isomata", a drama of the Union of Southern California. After visiting nearly every country this side of Asia, the change is rewarding. Clarence was employed by the DuPont Chemical Co. since his graduation from M.I.T. until 1946. Thanks to its largess, he has travelled ever since, trying to be useful in Montclaire, N.J. between times.

Our ever distinguished classmate, Dean Emeritus, **Andrey A. Potter,** of Purdue University, Indiana, has been honored again. His many degrees and honors are now joined by an award in his name, recognizing the undergraduate teaching effectiveness at Kansas State University, Manhattan, Kansas. Dean Potter was Professor of Engineering at Kansas State University from 1913 to 1920. He was also Director of Kansas State Engineering Experiment Station. The award provides $3000 annually at Purdue University, to the top winner of its Electrical Engineering Department there. The Potter Best-of-Engineering Award has a three-fold purpose: to reward outstanding undergraduate teaching; allow students to select winning faculty members each year and encourage innovation in teaching.

Another modest but highly distinguished classmate of 1903 is **J. Howard Pew** of Philadelphia, Pa. He was recently retired as president of the Sun Oil Co. to become chairman of the executive committee. During Howard's regime, the company grew twenty-fold, from a modest firm of a few U.S. States to its present international limit. As a petroleum company producer, ship builder and subsidiaries, there are 27,000 employees with headquarters at Walnut St.; at Marcus Hook and five other refineries. It is now the fourth largest petroleum company and received the William Penn Award in helping our nation through two world wars. Howard was honored with a Gold Medal for achievement as "Grand Old Man", by the International Petroleum Exposition in Tulsa. Other honors his way are the Silver Beaver and Silver Antelope Awards of the Boy Scouts; the Franklin Institute Medal for management and the Pennsylvania Society Gold Medal for distinguished achievements in humanitarian and civic fields.

In conclusion, Howard now tries to relax from his long, busy career as a member of the Union League of Philadelphia; its country club, racquet club, and Marion Cricket Club. Weather permitting, he also enjoys some golf on Wednesday afternoons.—**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

04

The news of the death of our classmate **Amasa M. Holcombe** was a great shock to me, as I knew he had made plans to attend the June Reunion. He and his wife have been regular attendants every year and in addition to that have been our traveling delegates furnishing interesting news items for our monthly column. Maynard was always a loyal booster for M.I.T. and the Class of '04 and his passing will be a great loss to us all.

The *Review* office forwarded me the following item of news from **Fred M. Pierce**: "My score is five children, thirteen grandchildren and eleven great grandchildren. What's yours?" That is quite a record. Who can top it?

Arthur P. Porter writes as follows: "My health is good and I enjoy life here in our rambling colonial house on the bank of the Connecticut river. My one regret is

Herman Eisele, '05

not having my wife here to share it with me. Five years ago she fell and broke her hip whilst walking on the lawn and has had to be in a local nursing home ever since. Physically, I keep busy with my garden and cutting wood for our fireplaces. I still enjoy a good game of chess and trying to figure out the new terminology in the *Technology Review!* Best wishes to all my friends.

My sincere thanks to Fred Goldthwait, Secretary, Class of '05 for making Alumni Day a pleasant one for me.—**Eugene H. Russell, Jr.,** Secretary, 82 Stevens Rd., Needham, Mass.

05

Our 66th Reunion on Alumni Day was at least a social success, which is about all we should expect, considering there are only 30 of us left. Nineteen of us are in Florida, Pacific Coast, Texas and Arizona —in New England, a total of eight. However, we mustered a table of eight, including Leonard and Beatrice Cronkhite, Charlie and Isabel Smart, Elizabeth Babcock, Mildred Stevenson, Art Balkan, Gilbert Tower and Ruth and your Secretary. Charlie and Isabel came in on Sunday, and we enjoyed with them the International Buffet and the Pops.

Leonard Cronkhite apparently has recovered from a threatening disorder of last year and seemed "in the pink." We learned that Beatrice was attending a function the same week at which a new Radcliffe building was to be named in her honor. The Smarts had just finished a tour of Louisiana, Alabama, and Mississippi. Charlie is still adding to his museum of old surveying instruments, and suggested that he would be pleased to receive any real old transits, etc., which you might have lying around. Isabel is the same old spark-plug. She is interim Secretary (of something) at Russell Sage College in Troy, N.Y. A toast to the "good old naught fivers, who couldn't be with us" was offered and drunk, with all our best wishes that the others could join us on our 70th.

Too late to get into the previous issue is a letter, with a glossy print taken five years ago, from **Herman Eisele,** Course XIII, giving a brief biography. I quote, "After graduation in Naval Architecture in 1905 ship building was at a very low ebb in this country. There were no openings. Accordingly, I settled for drafting positions with various Cleveland transmission, bridge, crane, and blast furnace design organizations. All excellent experience but little money. So I decided to go into independent practice in factory equipment and production machinery design. This work led me into textiles, boilers, rotary dryers and eventually into containers. In the container field, initially I designed equipment for the production of wooden oil and whiskey barrels and later for steel drum fabrication. I specialized in designing labor saving machinery for steel drum production for sixty-eight years, much of it for the Container Division of Jones and Laughlin Steel Corporation for whom I am still consulting engineer.

"Then in 1933 I qualified for registration as a Patent Attorney in the United States Patent Office and prosecuted applications for patents and trade marks in my field along with my engineering activities. I married Bertha M. Uhl, a teacher, in 1909, who died in 1966. I have one daughter, Ortrud Higgins, who is a tax expert. Answering your question about my still going to my office five days a week, the answer is 'yes.' Of course, I have a number of ailments and limitations but I take them all along to the office thus giving them a good workout." Unless the picture is artifically juvenilized, Herman must be the youngest looking fellow in our class.

Last Tuesday Ruth and I journeyed over to the Kenway farm in West Franklin, N.H. We should report them "in good shape, considering." Hub gets into his Boston office almost every day, although he reports he is "creaking at several joints." Helen seems i.g.s.c. (see above). Incidentally, while there we saw Oliver Marcy, who is still trying to prove his point that raising top drawer tulip bulbs in New England is possible. Hub and I are still expecting to see Alice and **Bill Spalding** soon, as they again promised last winter. A few hours after our return home, Peg and **Bill Ball** walked in, and we had a grand visit. They had been touring Maine and Nova Scotia, also stopped to see Bill Jr. in Connecticut. Bill hasn't changed a bit. Seeing him in the flesh I am now sure he is the youngest looking man in the Class. However, the fact that he has sold his big boat indicates that he has probably lost a bit of his athletic instincts. Peg was "just fine." Remember how she and **Prince Crowell** did the under-the-rug act at Old Lyme?

Through the Alumni Association I learned that **Arthur H. Howland,** Course IV, has moved from 30 Summer St. to 15 Winter St., Holliston, Mass. Notice a mere change of season. He reports, "Age 88—my immediate family are all dead, and I am contending with arthritis, sciatica, or something similar." Arthur did not graduate, but indicates his loyalty with a nice contribution to the Alumni Fund. This reminds me that although we now have no Class Agent, we could contribute as a tribute to **Bob McLean** who represented '05 in this area so effectively. **George W. C. Whiting** writes, "Still active at 87 and interested in my business, Whiting-Turner Contracting Co. (Baltimore)."

Isadore Nye, Course V, died on July 12, 1971. For the benefit of the Course V men, who may not remember him, the name at graduation was Niditch. For several years Izzy had been in the aluminum siding business.—**Fred W. Goldthwait,** Secretary, Box 32, Center Sandwich, N. H. 03227; **William G. Ball,** Assistant Secretary, 6311 Fordham Place, Bayshore Gardens, Bradenton, Fla. 33505

06

In the July notes we speculated on attendance on Campus on Homecoming Day, June 7. The usual regulars—**Bill Abbott** and **Walter Davol** did not appear but our class president, **Stew Coey,** did come down from Newbury, Vt. to join Anne and **Bob Rose** from Marblehead and Marion and me and **Bertha Chase**—only six for our sixty-fifth.

On my last count 70 classmates were living and 416 deceased. Nine widows were listed with '06 and I suspect they contribute to the Alumni Fund—bless 'em! Our class has a special fund too. As you may recall, at our class meeting in June '66 "the members present expressed an interest in setting up a Memorial Fund, within the Alumni Fund" and authorized the class officers—Chase, Coey, and Rowe to establish such a fund after study and consultation. That was done and the '06 Memorial Fund became a reality. It started with a sizable principal amount and one half the annual interest is added to the principal and will

continue to be added for many years to come. The other half goes for scholarship aid. I recently checked the status of the Memorial Fund with Ken Brock, the Executive Director of the Alumni Fund, who wrote me that our Memorial Fund totalled over $25,500 as of July 1, 1971 and that interest of near $1000 was added to principal. A similar amount presumably went to scholarship aid—allocated to a general account—"so that the money is promptly made available to a student or students." Such help is really needed for "beginning with the summer session in 1972, tuition will jump $2500 to $2900 a year. You may remember that the number of students entering with us in 1902 was unusually large because our $200 tuition was to go up to $250 the next year.—Inflation?

Early in June we received a long letter from **Jim Wick,** from Youngstown, with several snapshots in color of his large house and beautiful elms, tulip trees and evergreens on his six acre estate. Jim was very sorry that he would not be able to attend our 65th. . . . We also had a long and interesting letter early in June from **Jack Norton** from Tryon, N.C. replying to mine. In that letter I had quoted; "If Winter comes can Spring be far behind", and Margaret found the author. It was Shelley who wrote "Ode to the West Wind." Jack was sorry too that he couldn't make our 65th. We were sorry too, Jack and Jim, and thanks for the long and interesting letters.

We have two deaths to report—**Ernest Maxwell Smith,** a graduate of mechanical engineering, died December 31, 1970 in Avon, Conn. Ernie was with us all four years and had been a loyal, active classmate; paid class dues; attended reunions and wrote to the class secretary on occasion. He was born October 24, 1883, in Syracuse, N.Y. where he attended a private school. He was a member of the freshman football team; in the cast of the Tech Show; "A Scientific King", in "The Flower Dance" and in the following year's show "Simon Pure Brass", as one of the gold dust twins. He was secretary-treasurer of the Institute Committee, 1903-1904; a member of the Mechanical Engineering Society; Osiris, and the Technique Electoral Committee. Ernest soon obtained employment as a mechanical engineer in three chemical companies in the United States and then in English, French, and German plants. In 1915-1916 he was a student at Columbia School of Mines. By 1925 he had become department supervisor at the Stanley Rule and Level Co., New Britain, Conn. He continued there for ten or more years in various similar positions and by or before 1955 he had retired to his wife's ancestral home, on a large farm in Old Chatham, N.Y. Later they moved to Edgartown on Martha's Vineyard and for the past few years he had been a patient in the Brightview Convalescent Home in Avon, where he died.

Daniel Michael Luehrs, graduate in naval architecture, died January 24, 1971 in Philadelphia. Dan was with us during two years as a Special, having previously obtained a B.S. in the Case School of Applied Science in Cleveland. He was a consulting engineer there several years, then was president and treasurer of his own company in Cleveland and later in Philadelphia, Pa.—**Edward B. Rowe,** Secretary-Treasurer, 11 Cushing Rd., Wellesley Hills, Mass. 02181

07

By the time these notes are in print one of the more active members of the Class of '07, **Willis G. Waldo** will have celebrated his 88th birthday. His very pleasant letter follows. "In his recent and much appreciated letter to '07 survivors our classmate **Jim Barker** remarks that he has long been used to turning first to our Class Notes when opening the *Review* and feels the 'aching void' caused by their absence since the passing of our faithful secretary, Phil Walker. While I was a member of our class only during the year of my graduation (having been out for two years due to finances) and my acquaintance among '07 men is very limited, I have always been interested in the doings of my classmates whether I was fortunate enough to know them or not and I have missed our class news in much the same way as Jim Barker.

"Perhaps the most newsworthy item that I can contribute is not the details of my office and field work as a registered engineer in the State of Florida, but the fact that I am still in daily active practice of engineering at the age of 87 and look forward to my 88th birthday early in September. When most men retire between the ages of 45 and 65, how do you go about pushing forward the age of commercial usefulness to nearly twice 45? That sounds like a 64-dollar question and of course there are many answers, so I call it good luck, a disposition to smile at my troubles and a self-imposed health program that doesn't take life too seriously.

"Southern Florida—that well known haven for oldsters—does favor youthfulness for many who have passed their three-score-and-ten. Perhaps the rapid growth of our white-haired population here indicates that many are finding this a good place for fun in their eighties. Like many others, I enjoy flower gardening, along with a youthful girlfriend of a mere 79, who supplies the green thumb know-how that never did run in our family. While I have never seen high hollyhocks nor tall dahlias hereabouts, the possibilities of attractive semi-tropicals more than compensate us.

"Engineering-wise, my opportunity for useful service here has been prolonged by my local experience of 25 years and being familiar with our soils, weather and other conditions, I have been doing considerable work in the designing of foundations for commercial and other buildings. There are also young architects and engineers in this area who have never passed the State examination for registration and their plans must be approved, signed and sealed by a registered engineer or registered architect before a permit for construction will be granted.

"In short my 'youthfulness' at 87 has been due to good health, work and play that I enjoy, the use of fresh fruits and vegetables and a few health foods such as raw wheat germ and natural vitamins, as well as the avoidance of such life-shorteners as liquor and cigarettes along with sugar, ice cream and other sweets, white bread and cereals. Does this take all the joy out of life? For me it hasn't—on the contrary, how else can you get up mornings feeling like a million dollars when you have acquired many years but no such money?"

Paul L. Cumings sent in the following letter, written by his wife Laura. "Following Jim Barker's suggestion, I will try to do my bit to keep the class notes going. Since my retirement in 1963 from the John Hancock Mutual Life Insurance Co., as construction consultant, I have continued to live in Boston—moving in '68 to the Prudential Center in the 'New Boston'. Our apartment, the Gloucester, overlooks the site of the demolished Tech Chambers, Armory, and Drill Grounds. We enjoy this open area, with a view of Boston Harbor and the Blue Hills in the distance. The old Copley Square and Lenox Hotels are the only two landmarks left in the immediate neighborhood. The new addition to the library is rising on the site of the old B.A.A. Club House. The finish line for the Marathon Races is now on Boylston Street in front of the Prudential Tower Complex. The Prudential Center is built on the old B. and A. railroad yard, so now the trains run under it.

"We still continue to spend our summers at our Cape Cod home in West Falmouth. We prefer the Spanish island of Mallorca, which we've visited nine times, but spent a few weeks in Florida this winter instead. I still manage to get around and enjoy life despite my inability to read or write. I was glad to get over to M.I.T. last year for Homecoming, but disappointed not to find any of my classmates registered."

Walter B. Kirby, who has become one of our better correspondants, sends some news about, as he says, "a few inactivities of an old timer." He writes: "When I was a boy, we spent our summers at Southport, Maine. Not far from us lived an old sea captain, named Cyrus Pierce. He lived in an old Colonial house with his two cats, named Admiral Dewey and Admiral Sampson for companionship. Often the two Admirals would jump into his dory to assist in pulling the lobster pots and to eat some of the fish used for baiting the traps. 'Captn Burse' kept us well supplied with lobsters. I asked him what he did during the long winter months, he replied, 'Sometimes I just sot and think, and thin agin I jus sot.'

"On my flagstone terrace, surrounded by my flower gardens with many blossoms of the season, I sit in the sunshine and emulate old 'Captn Burse'. I also feed the birds with sunflower seeds which I hold in my hands. I have found the chickadees to be very friendly. They sit on my arms and shoulders, and one has decided that the top of my head makes a wonderful landing field, so now I wear a cap.

"A family of garter snakes has lived for years under stone steps nearby. I have attempted to make friends with them, but they do not trust me, but stick out their

tongues and say 'Go too'. However, every year they present me with a few snake skins. It is remarkable how a snake can emerge through its open mouth, leaving its entire skin including its mouth, intact. The snakes are a great assistance in keeping down the insect population in my garden. For all-year entertainment, I have erected a large bird-feeding station and two bird houses in full view from my living room picture window. The antics of the crows' free-for-all, fighting for the largest meat bone or piece of fat, etc., is worth the price of admission. Cheerio and best greetings to all."

Thanks to all who wrote in this time but now the '07 news cupboard is bare, so please drop a line about your activities, or even your "inactivities", to Kathy Sayre, Class Notes Editor, Technology Review, M.I.T., E19-430, Cambridge, Mass. 02139

08

We have received a supplementary letter from **George Schobinger,** who was reported in the June issue: "As I looked over the biographical sketch that you rewrote for me it looked more than ever like an obit, and I decided that you ought to find space for Helen in the next issue of the '08 Class News, because Helen is just as much a member of the Class as I am, and my story is only the small half of it. I am sure the wives of our classmates will find greater pleasure following the life of a wife of an engineer and imagine the vicissitude of bringing up a child, as she did, seventy miles from the only doctor in five hundred square miles, living in a canvas tent, and hearing the braying of the mules in a grading camp instead of a noonday whistle, and seeing the Indian women at the pump with wash kettle instead of the washing machine—in fact living a really primitive life, down to the realities just as our New England ancestors did. At any rate, try to persuade the editor to tell how the other half lives, and remind the Class that this is an actual story of the life of two members of the Class of '08."

Have just received a copy from the *Boston Globe* of April 5 with an obituary of our classmate **H. A. Cole, Jr.** a Hingham resident for more than half a century and telephone company pioneer, who died April 3 at the Cohasset Knoll Nursing Home, age 86. Mr. Cole was born in Philadelphia, grew up in Somerville. He began his career with the New England Telephone Company in the factory of his uncle Charles Williams where Alexander Graham Bell had his laboratory and conducted experiments which eventually led to the invention of the telephone. In his late years Mr. Cole was almost wholly involved in the development of long distance transmission dialing. He retired from the telephone company in 1950. He is survived by his wife, Mildred (Burr); two sons, Frederic B. and Herbert A., both of Hingham; a daughter, Alice (Mrs. Lionell LaRochelle) of Ft. Lauderdale, Fla.; seven grandchildren and four great-grandchildren.

Those attending the Alumni Luncheon June 7, were Wilfred E. Booth, Leo Loeb, Franklin T. Towle, and Joseph W. Wattles. . . . We have the following changes of address to report: Mrs. Herbert A. Cole Jr., 16 Elm St., Hingham, Mass.; Louis S. Gordon, Apt. 1532, 910 West Ave., Miami Beach, Fla.; Herbert W. French, 180 Elsimore St., Concord, Mass. —**Joseph W. Wattles, 3rd,** Secretary, 26 Bullard Dr., Weston, Mass. 02193

09

There were 12 of us at the 1971 Homecoming and 1909 luncheon on June 7, held in the Rockwell Cage—Chet Dawes, Margaret Davis, Tom Desmond, Mayo Hersey, Ed Howe, Ben and Barbara Pepper, Art and Betty Shaw, Laurence Shaw, Henry and Madge Spencer—a very substantial number for a class whose graduation occurred sixty-two years ago. As usual, Alice Desmond, who stayed at a Boston hotel, did not feel equal to attending the Homecoming program. The very substantial gifts of the classes of 1946, 1931, and 1921 were presented to President Johnson. A feature of the occasion was the presence in the front of the room of a long rowing shell presented by the Class of 1921, in addition to its financial gift, in recognition of the fact that the class was instrumental in the early 1920's in starting rowing at M.I.T. in a second-hand shell. Seven members of the original crew were in attendance at the presentation. (See pages 77-79 in the July-August *Review.*)

At 11:00 a.m. a reception for class secretaries was held in the student center where refreshments were served. We had the pleasure of meeting Kathy Sayre who edits our class notes and assists the secretaries with timely information, particularly the due dates of the notes. She is taking the place of Brenda Kelley, recently promoted to Associate Editor, who was always most helpful to the class secretaries. We also met John Mattill, editor of the *Review,* who has been responsible for its present attractive format and for its expansion both in covering M.I.T. activities and current scientific developments.

In the early afternoon we attended the Memorial Service for M.I.T. alumni in the M.I.T. chapel. It included an organ prelude, hymns, excerpts from the Book of Psalms, a Prayer of Remembrance, and appropriate quotations from well-known poets and writers. The worship was conducted by Williston Wirt '21, the eulogist was Howard L. Richardson '31, and John Cook was the Institute Organist. The '09 alumni memorialized were: Elliott Q. Adams, Rea E. Blankenbuehler, Hardy M. Cook, Michael J. Daley, Warren L. Dubois, Newman B. Gregory, Kenneth S. May, Samuel N. McCain, Leonard W. Pritchett, Julius H. Serra, and Joseph H. White.

We received from **Mayo Hersey** the following obituary, which appeared in the *Providence Journal,* of his wife Frances (Warner), who died on May 2: "Mrs. Frances Hersey, 82, of 18 Medway St., a former college professor and the author of numerous collections of essays, died yesterday at the Hillcrest Nursing Home, East Providence, after a two-year illness. She was the wife of Mayo D. Hersey, a professor of engineering at Brown University. Mrs. Hersey was former head of the English Department at the New England Conservatory of Music, where she taught from 1944-1948. Before that she was a lecturer in English at Simmons College, and from 1916 to 1921 she taught English at Mount Holyoke and Wellesley Colleges. She was the author of numerous books published under her maiden name, Frances Lester Warner. These include essays on family life that first appeared in *Atlantic, Harper's* and other magazines. In the early 1920's she was assistant to the editor of the *Atlantic Monthly* and she also was a book editor. Mrs. Hersey graduated from Putnam High School, Putnam, Conn., and in 1911 graduated from Mount Holyoke where she was elected to Phi Beta Kappa. She was given the honorary degree of Doctor of Letters by Mount Holyoke College in 1937. Before beginning her college teaching career she taught English in the high schools of Newton and Worcester. Mrs. Hersey had many interests including the piano and violin. She was an accomplished seamstress and cook, and she fashioned hammered-metal objects, built marionettes, and did origami, the Japanese paper folding art. She also enjoyed photography, gardening, flower arranging, bird watching, and collecting rare seashells. She was a member of the Ladies of the Faculty of Brown University and the Women's Alliance of the First Unitarian Church of Providence." We have expressed the sympathy of the Class as well as our own to Mayo.—Secretary, **Chester L. Dawes,** Pierce Hall, Harvard University, Cambridge, Mass.

10

The following were present at the Homecoming Reunion in June: Mr. and Mrs. Robert Burnett, Herbert S. Cleverdon, Ralph W. Horne, Fred R. Lufkin and Mr. and Mrs. Murray H. Mellish. All those attending seemed in good health and good spirits. Your Secretary, however, had trouble in perambulating and required a cane to get from one place to another.

Jack Babcock sent a note late last month informing me of the death of **Jim Tripp.** All I know is that he died July 26, 1971 and that the end must have been rather sudden as I had a note from him some time in June as follows: "Life in retrospect is a fine picture if one used the right paint. I find I did."

George Goodspeed writes as follows: Since my retirement in 1957 I have been working on my own research; for the past few years studying rapakivi rocks in the Salman River Mountains of east central Idaho. The University of Washington has furnished me the use of an office and an excellent petrographic microscope." . . . **Ludwig Rosenstein** writes as follows: "My 85th birthday has come and gone. I am active in my one-man business and leading a quiet life with my wife, children, grandchildren and great-grandchildren in the existing city of San Francisco."—**Herbert S. Cleverdon,** Secretary, 112 Shawmut Ave., Boston, Mass.

11

As he has done so well for past reunions, **Jim Duffy** has written his "Log" of happenings at our 60th for the benefit of those who could not be there and to bring back pleasant memories to those who were. Here it is: "Once again I have been appointed recording angel (although it is a devil of a job) to report the activities of our 60th Reunion. In one of Obie Clark's letters soliciting our attendance, he stated this might well be our last formal reunion. With due respect to him, I think he is overly pessimistic. I talked to one of our classmates, whose name I will not divulge because of the current furor over the invasion of privacy. He told me that he got married a couple of months ago and now he and his bride were looking for a nice two bedroom house in a good grade school neighborhood.

"Well, to get back to Cambridge, our reunion committee consisting of **Morris Omansky, O. W. Stewart** and **Obie Clark** as chairman, did a magnificent job in making arrangements so everything ran as smoothly as a Timken bearing. The festivities opened with the class dinner in the Stratton Student Center on Saturday evening. All the private dining rooms in the center have names, and the committee, with unparalleled foresight, chose the one known as 'The Room with the Twenty Chimneys' for our dinner. In attendance we had 20 classmates and nine guests (presumably wives). When 20 individuals, as illustrious as we eleveners, recount our achievements over a period of 60 years, one chimney apiece is barely adequate to carry off the hot air. The dinner was preceded by a cocktail hour at which we could more intimately renew our friendships. At it I learned of a new cocktail. Don't ask me how I learned. It is called "The Card Table"—four sips and your legs fold under you. Our peerless president, **Howard Williams,** served as chairman with his usual savoir faire, (that's French for 'unlimited resourcefulness'). His experience in running stockholders' meetings gave him finesse, and as neither Wilma Soss nor the Gilberts were present, he was completely at ease. The following were present: Oberlin Clark, James Duffy, Livingston Ferris and Mary, Leroy Fitzherbert and Marjorie, Joseph French and Yolanda, Gardner George and Gurley, Charles Hobson, Willis Hodgman, George Kenney, Morrel MacKenzie, Roy MacPherson, Morris Omansky and Ricca, Ralph Runels, John Scoville, Edward Sisson and Sadie, Suren Stevens and Artemis, O. W. Stewart and Gertrude, Howard Williams and Katharine, Irving Wilson and Ray Wilson, secretary of the Class of 1912.

"Howard first paid tribute to Obie Clark for the superlative job he was doing in the thankless task of Class Secretary. Obie then read letters of regret from the following classmates: G. Arthur Brown, Paul Cushman, Richard Gould, Curtis Kinney, Oliver Powell, Harold Robinson, Edward Seuss, Gordon Wilkes, and Walter Wilson. Most of the regrets were due to physical infirmity, but a few were due to conflicts with golden weddings and graduation ceremonies for offspring. Howard then called on **O. W. Stewart** who is Class Secretary for the Alumni Fund Drive. He gave us some very interesting statistics. There were 463 individuals who at one time or another were considered to be members of the Class. Of these, 337 have died leaving 126 presumably living at this time. Of these, 93 have contributed at one time or another to the Alumni Fund. Of the 93 members, 57 contributed to the current year's fund, a ratio of 61%. The next and concluding feature of the dinner was the so-called 'talkaround', where each classmate told of his past and current activities. Probably the most dramatic incident was 'Chief' Wilson's reading the testimonial which the Board of Directors of Alcoa gave him when he recently retired as its Chairman. 'Bunny' went with the company (which was then known as the Aluminum Company of America) directly upon his graduation and achieved the pinnacle of success by becoming chairman of its board of directors. The company makes more aluminum now in a couple of days than it did in an entire year when he went with it. You all know George Kenney who was MacArthur's air general. It has been said that much of General MacArthur's success in the Pacific was due to his '3 K's'. Kenney was his air general, Krueger was his army general and Kinkaid was his navy admiral. **'Zeke' Williams** built Erwin Wasey into one of the most prestigious advertising agencies in the world. So much so that Winston Churchill invited him and Katharine to his country home at Chequers. Space does not permit the recounting of the achievements of many more of our classmates who worked in less well-known fields, but whose efforts were equally productive of personal happiness. As La Rochefoucauld has said 'The art of using moderate abilities to advantage often brings greater results than actual brilliance'. So much for Saturday.

"Early Sunday evening the entire alumni body met in the Student Center to enjoy a delicious International Buffet, after which we were taken by bus to Symphony Hall for 'Tech Night at the Pops'. **Bill Coburn** and **Robert Schurig** with Elizabeth joined us that evening. Maestro Fiedler is not a big man, but with his white hair falling almost to his shoulders with a curl at the bottom like a ski slide, and his ruddy countenance heightened by a shell pink jacket, he was truly an impressive figure. The program opened with Sousa's rousing 'Washington Post March', followed by that Pops trademark, 'Orpheus in Hades' by Offenbach, the same composer who wrote 'Gaite Parisienne'. For old timers there were selections from 'Showboat' and for the younger members there were selections from 'Cabaret'. The frosting on the cake was Beethoven's Fifth Piano Concert played by a young man with prodigious talent named John Butterick, who is also a teacher of Music Theory and History at Tech. The concert ended with the audience on its feet singing and the orchestra at its best playing that temple-throbbing 'Arise Ye Sons of M.I.T.'. I don't know how the music was scored, but I do know it was rendered 'Fortissimo con Spirito' (loudly with spirit). Thus endeth Sunday.

"Monday noon the entire alumni body assembled for the traditional luncheon and presentation of gifts. **Jack Herlihy** joined us for this affair. Although he is retired he still has that familiar '6 o'clock profile' (straight up and down). 1921 was the 50 year class and was accorded the place of honor. Their president told us it was the class which introduced varsity rowing to M.I.T. In front of the speakers' platform there was what appeared to be a long low table covered by a gray cloth. The speaker asked all 1921 classmates who had rowed in the varsity crew in 1921 to come forward and stand in front of the platform but facing the long low table. At a given command they removed the cloth and there was the most beautiful eight oared shell you could ever hope to see. The only thing I could compare it to was the royal barge which the King of Thailand uses to lead the ceremonial processions on the river. Each was superb for its purpose. As this gathering was an all-alumni affair, it gave us a good opportunity to fraternize with the alumni of other classes.

"For those of us who sought food for the mind as well as for the body, during the morning and again in the afternoon, the so called 'Great Debate' was held in Kresge Auditorium. The morning subject was 'Can Government and Industry be More Responsive to Society's Needs?'. The afternoon subject was 'Can Our Institutions of Technology be Made More Responsive to Society's Needs?'. The participants in each session were world-renowned for their leadership in education industry and science.

"In the late afternoon Kresge Auditorium was filled with alumni assembled to pay tribute to Dr. Killian, who is retiring as Chairman of the M.I.T. Corporation. His remarkable achievements were recalled and he responded most graciously. After the meeting Dr. and Mrs. Killian accepted the personal good wishes of a seemingly interminable receiving line of alumni. When the end of the line finally was reached, a reception took place at which liquid refreshments were abundantly available. This afforded us a last opportunity to visit again with each other. Then in the words of the poet, 'We folded up our tents and like Arabs, silently stole away'.—Jim Duffy."

I have two address changes: Minot S. Dennett, Apt. 14, 3717 46th Ave. So., St. Petersburg, Fla. 33711; and Dr. Carl S. Ell, Room 138 R.I. 360 Huntington Ave., Boston, Mass. 02115.

Col. **C. Phillips Kerr** died on June 27 in the Fairfax Hospital, Va. I'll have a little more about the colonel in the December Notes.

Dennie's granddaughter, Deborah Fenn Denison married Alan Arthur Schock in Cornish, Maine, on June 5.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

DO YOU REMEMBER the Tech dining room in the old Union where a student

waiter received the munificent sum of 20 cents for waiting on table at lunch. He could then purchase a plate of Boston baked beans for 15 cents leaving him a net profit of one nickel for his effort. Those were the days! Contributed by **Harold Mabbott.**

The "All-New Alumni Homecoming" on June 5 and 6 was most successful with an attendance of perhaps 1500. Five classes held reunions on campus. I was the guest of the Class of 1911 at their 60th reunion dinner with about 30 present. We had an attendance of eight classmates at our class luncheon, including John Barry, Fred Busby, Jerry Hunsaker, Mac McCormack, John Pettingell, Cy Springall and Marjorie, and Albion Davis. The main program included a discussion on science and public policy by ten distinguished representatives, under the direction of President Johnson and Paul Gray, the Chancellor elect, with a summation by our next President, Jerome B. Wiesner. A special reception was also held as a tribute to our retiring Corporation Chairman and former President, James R. Killian, after 22 years of distinguished service. We also enjoyed a capacity performance of Tech Night at the Pops.

Wallace Murray has moved to Maine and now lives at his son's home right on the lake shore at Sebago Lake, Maine (Box 17) 04075. He reported much snow and cold weather which he enjoyed last winter and on March 13 sailed from New York on another trip, this time on the *Gripsholm.* He writes, "We first arrived in Madeira, then to Cadiz and Seville and over to Tangiers and Tetuan in Morocco. Tangiers is only mildly interesting but I liked Tetuan, which was really Moorish. Then to Granada and Malta. We saw the ruins of Ephesus, which in the 18th century was a mighty city. We walked to the church where St. Paul went and wrote his well-known epistles. Then to Bursa, ancient capital of the Ottoman Empire, from which we sailed through the Bosphorus into the Black Sea. Our first stop was Sochi, a health and vacation resort at the foot of the Caucasian Mountains. Most of the visitors came from Russia. They treated us splendidly and we could not help liking them. This also applied to the people we met in Yalta, and similarly in Constanti, Romania, and Varna in Bulgaria. Istanbul is a most interesting city, a mixture of East and West, with very narrow streets in the old city where few tourists go.

"In Greece, we visited the ruins of many once-great cities like Corinth, Mycanae and Delphi. We found the city of Rhodes inhabited and largely unchanged for centuries. Athens is modern, surrounded with the famous ancient ruins. Mykonas is a quaint fishing village. From Greece we went to Tunisia. It was once ruled by Carthage and when destroyed by Rome, Tunisia became an important part of the Roman Empire. Due to its rich soil and ample rainfall, it served as Rome's bread basket. It was later conquered by the Arabs and to this day is a Moslem and Arab city. Then to Majorca, Gibraltar and Portugal, sailing from Lisbon to New York after six weeks of delightful cruising."

Chet Dows is, as usual, spending the summer at his cottage in Madison, Ohio, on Lake Erie. This was his 35th year there. Chet is now 84 and arthritis hit him last winter in the hands, wrists and shoulders, appreciably interfering with his usual activities, including driving. He is feeling somewhat better, however, and hopes to be able to visit his son and his daughter, living in Pennsylvania and Garden City, N. Y., this fall, and perhaps include his beloved New England. Our very best wishes, Chet! . . . Again, we are glad to receive a note from **Fritz Shepard** who is also wrestling with arthritis and does not get about very much. He says that Alan Shepard, Jr., the astronaut, is his nephew. He was the first man up ten years ago, as some of us recall, and despite ear trouble, he stuck to it and made the flight. He was promoted to Rear Admiral. . . . We have another letter from **Julius Rosenburg,** outlining his activities. As previously mentioned, he left Tech for Sheffield and graduated as a civil and sanitary engineer in 1911. He took a job with the city of Providence Sewage Department for a year, but did not like the work and secured a position as assistant buyer at William Filenes in Boston. Deciding he had had enough of the East, he moved to Detroit where he became a successful real estate investor. He went broke in the the 1932 depression and after a graduate course in economics he again started from the bottom. Business improved rapidly and he continued in Detroit until his retirement to Miami in 1964. "And here I live with my wife, hale and hearty, I hope."

Ken Barnard reports that his grandson, James Calvin, has returned safely from Okinawa, where he was serving in the Navy. He has four children, two adopted Koreans, all under five years, who visited with Ken at the old homestead on Cape Cod this summer. . . . We have a letter from Ruth Morgan, wife of **Alfred Morgan,** who lives in Upper Montclair, N.J. He left us after one year in Course II and became a writer of many books on various subjects. These included children's books on animals and fish, glider building, chemistry, radios and electronics. Quoting from "Who's Who," he contributed to the development of radio telegraphy, and is the holder of patents on radio and mechanical devices. He was president of five different organizations engaged in book publishing and radio manufacturing. He was twice married and has four sons and fifteen grandchildren. Up to recently, he has enjoyed boating as well as gardening, but his eyesight and hearing are no longer good. . . . **George Chambers** writes from Buffalo that he and Frances celebrated their golden wedding anniversary last January. Their four sons got together and arranged a reception in the parish school, which over three hundred friends and relatives attended. "It was quite a thrill for us to meet our friends and to hear from many others who lived out of town and could not attend." . . . We are glad to hear from **Jesse Hakes** who recently had a prostate operation from which he has fully recovered. Jesse is one of our 15 classmates who still enjoy active work. He says this summer he is busier than ever with his nursery and tenant houses; also he still has no difficulty in running the lawn mower. "And speaking of field day in our freshman year, I wish to say that you were wrong when you reported we won the decision for tug-of-war. I was on the team and am sorry to say we lost. True we had won, but the umpire put up his gun to declare the winner. We thought it was all over and quit—then were dragged to defeat. **John Pettingell** gave me an old 1909 photo, quite faded, of the sophomore team and I could identify ten men with **Cornelius Duyser** the anchor."

And now from this anchor man, who rates at 85 years, with McCormack, Guy and Slade as our senior citizens, we have the following observation, "I received the notice of Homecoming Day functions that were to be 'committed' at M.I.T. Boy, the price list! When I was at Tech, this amount would have seen me through a whole term. I am still a bit grouchy about inflation and the modern weather forecasters. I got my garden off to a good start despite their help(?). Well, stop by next summer and taste some prime corn!"

Nelson Breed is still reliving the wonderful trip he and his wife took to Greece and Turkey where, as an architect, he could revel in the beauty. This last winter they spent a month in southern Florida and enjoyed wonderful fishing and swimming. . . . **Jack Lenaerts** writes that he and Marion spent most of the summer in New England, visiting their families and friends and making their headquarters on Cape Cod. . . . **Henry Babcock** writes, "I am about as busy as ever and have all the work I can handle. I am still working on my second volume: *Valuation of Investment Property.* My first volume: *Appraisal Principles and Procedures,* went into a second printing. Ruth and I celebrated our 54th anniversary in June. We have three great-grandchildren. We are summering in Goshen, Mass. until mid-October. Count on us to attend our 60th." . . . A note from **Paul Tyler** reads, "No news except that we drove from Florida to Washington and Baltimore last spring, the day after the demonstration. We had no trouble but I have never seen such an assemblage of 'hippies' and other unsavory characters nor so many police." . . . **Fred Busby** says he is in reasonably good health and still teaching, but this will probably be his last year. He is still living with his daughter and her husband near Boston. . . . **Walter Slade** writes, "Sorry to advise that Esther has had a slight setback which prevented my attending Homecoming this year. She has needed me with her very much of the time, but is slowly improving. I am writing for news regarding our 60th. Best wishes!" And the same to you and Esther, Walter. . . . A note from Marjorie says **Cy Springall** is fairly well and able to get about. Marjorie, however, has had a tough time with three operations, phlebitis, and flu, which prevented their taking their usual trip to Arizona last winter. We hope to receive much better news shortly.

Larry Cummings and Julie wrote that they had a bad winter in Indiana but were able to take a trip East to be with their daughter and family for Christmas. They

George P. Capen, '13, (left) receiving Governor's Citation for service to the community in Canton, Mass.

are planning a trip West this fall which will include Grand Junction, Colo. and Monument Valley, Indian country. If able they will then drive to the west coast. . . . A brief note from **George Brigham** in Ann Arbor reads, "I am well and working hard to solve the low cost, factory fabricated house problem about which I have written you. The outlook is good. I hope I can get to that 60th next year". . . . **Guy Swenson** is not in good health but is carrying on bravely. He tries to get to the office each day with the help of one of his sons. His sight is going more and more and he rests with difficulty. Our best wishes to you, Guy, and thank you for writing!

Hamilton Merrill writes from Bridgeport, Conn., regarding a trip he took last year to the Pacific Islands including Australia, New Zealand and Fiji. "Strenuous, but most interesting. We especially liked the three days we spent at the Yawasa Islands, just north of Fiji. The natives were so unspoiled that the children did not beg for money or candy. The south island of New Zealand was gorgeous, with the mountains and glaciers equal to the spectacular fjords and glaciers of Norway. We flew over them at low altitude, and it was most thrilling." Ham had a new hip joint with metal ball and plastic socket installed a year ago, and pronounced it a complete success after testing it out on the trip. He advises that he and his wife will celebrate their 50th anniversary in October. They now have three great grandchildren. Hearty congratulations!

Walter Lang writes a note which will have an appeal to many of us retirees when trying to reply to our requests for news. "The reason you have heard nothing from me since I last wrote is that I am doing the same things at the same location. My wife and I are enjoying life here since I retired six years ago, clearing the snow from the walks in the fresh winter air and mowing our limited lawn as well as digging in the ground during the summer months. And I keep busy fixing things about the house. I read quite a bit and like to read in the *Review* of the great progress in technology since 1912. Best wishes to any classmates you may see. Hope we can get together next year for our sixtieth." Thank you, Walter.

We greatly regret to report the sudden passing of **Bob Cox** on May 27 in Saratoga, Calif. where he and Helen had retired in 1965 after an exciting career as the owner of a large dude ranch in Dubois, Wyoming. Bob was stricken by an undetected malignant growth. As he wrote in the last issue of the *Review,* he had been most active during the past year, driving to New England and to Arizona and visiting many friends throughout the country. We have sent the sympathy of the Class of 1912 to his wife, Helen, and to his son, Dr. Robert S. Cox, Jr. and family, who also live in Saratoga.

At this time, in August, Helen and I have just returned from a month's trip in New England, including a large covered bridge party in Dummerston, Vt., with two weeks at Southwest Harbor, Maine where we have spent 30 summers in the past. We then visited with **Harold Brackett** and his niece in Limerick, Maine where Harold has a delightful old farmhouse with large flower and vegetable gardens which they tend themselves. We also visited friends and relatives in Quincy and on Cape Cod.—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

So this is the start of a new editorial year. We hope that you and yours have had as pleasant a summer as we have. The Alumni Homecoming was very gratifying as usual. The International buffet meal was both bountiful and extremely tasty. Our friends and classmates enjoyed the repast as well as the Arthur Fiedler "Pops". The noon-day luncheon was excellent as usual with good food and companionable friends, including the old stand-bys, Francis Achard, Mr. and Mrs. Ellis Brewster, the Capens, Burton Cushing, Walter Muther and charming daughter, Charlotte Sage, Philip Terry, and our President, Charles Thompson. The reception to our beloved but retiring James Killian and his wife was sad but rewarding. Many of our old friends of other classes were fondly greeted, and of course we enjoyed newer acquaintances. We were royally entertained prior to our departure from our old home town of Canton. Many citations were presented to us, including one from our Governor, Francis Sargent; a resolution passed by the Massachusetts Senate, American Legion, Canton Rotary Club, the Board of Selectmen, as well as many letters from former associates, including Ex-Governor and Ex-Senator, Leverett Saltonstall. It all was very gratifying and complimentary for the 50 years of participation in services of community, county, state, and national activities.

Our "retirement home" here in Biddeford, Maine is nearing completion. After September 1, we shall be very happy to greet any or all of our classmates and their families. We know that you have received **Bill Brewster**'s report on the wonderful share 1913 contributed to the Alumni Fund this year. To Bill and the other officials and agents of other classes, we should be thankful. Keep an open mind and encourage those of the administration of the Institute. They need your support in these trying and difficult conditions. Help President Nixon and our various legislative bodies to keep the United States, the leader of the world.

Our President (Class of 1913) writes as follows: "How nice to hear from you and learn of the progress on your new domicile. It isn't often that people of advanced middle age can make a change that should be very pleasing. Best of wishes for the September 'move-in.' On September 1, my daughter and grandchildren will have been with me a year. It's been quite a change-over for me. Had to give up some of my independence, but things have developed harmoniously. I am quite contented. Perhaps in the fall the children may want to take a trip to see the foliage. If so, I may be able to steer them toward Biddeford. I'll let you know. I'm dependent for transportation. Let me know your telephone number when you move in."

Little do we realize what our classmate, **Eddie Hurst** is attempting to accomplish. He is devoting much of his time to perfect a better and lasting treatment for preventive treatment of the great "death-killer", heart disease. Ed has been consulting with the eminent heart specialist, Dr. Paul Dudley White and Dr. Gordon S. Myers (located at M.I.T. Clinical Research Center). He believes that many retired scientists and engineers can assist the medical association in developing improved equipment to further control this universal destroyer of human life. If you are interested communicate with Edward Hurst (1913) at Duxbury, Mass. Ed, we appreciate all of the inventions you have made in assisting the blind. We wish you much success in your latest endeavors.

It has been very flattering to receive communication from Peter Grant, Martin

Phillips, and Fred Lehmann regarding our 1913 efforts regarding the Alumni Fund and our 60th Reunion in 1373.

As usual **Allen Brewer** is one of our best correspondents and we quote: "Looking through the *Review* the other day reminded us that we have not as yet complimented you and Roz on your venture in building your retirement home in Biddeford, Maine. We presume by now it is completed and that you have moved in and are going through the 'growing pains' of rearranging furniture, drapes, etc. It's a lot of fun even though it is a chore while one is doing the heavy work. We have just bought a new rug for the Florida room and moved all the furniture out ourselves, because nobody else would do it as we desired. Now however, we are again settled and if you remember the room it looks quite dressed up. Did we tell you folks about our tour earlier this year to the South Pacific and the Orient? Anyhow, I'll repeat briefly. In February flew to Tahiti from Los Angeles, naturally starting at Miami. Then to Fiji, New Zealand, Australia, across the Outback of Australia to Singapore, thence to Bangkok, Hong Kong, Taipei, and finally for a few days in Japan before returning via Japan airlines to San Francisco. Thence back home, landing in Miami. It was quite an eventful trip. We saw a lot of New Zealand especially, and liked the country and people a lot. The same for Australia. Just one near 'casualty'. I fell off a ski-lift trying to debark carrying a cane. This occurred in New Zealand in the Alps area near Milford Sound. Since it was cold there we were bundled up in World War I overcoats, so this 'drapery' broke my fall—not even a scratch. So I'm still in good shape for the next reunion a couple of years from now.

"After we returned home I visited my opthamologist and he found the cataract on my left eye 'ripe' for operating, so he did the job. Local anesthetic, no pain, hospitalized just five days, and now I'm sporting a contact lens. They do this operation so casually these days that it's virtually minor. This constitutes our news from the Sunshine State. In reality it has been truly a sunshine deal this summer. Too darn dry with but little rain. But cheer up, maybe we'll get a hurricane before the end of the year."

Roz and yours truly have been elated at the friendliness and cooperation of those we have contacted since our arrival in our adopted state of Maine. Several visits have been made to the Kennebunk, Wells, and the Biddeford-Saco Rotary Clubs. So we are progressing. Keep the news of your activities coming—until December.—**George P. Capen,** Secretary and Treasurer, **Rosalind R. Capen,** Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

14

It is a great disappointment to have to report that, because of the state of his health, **Herman Affel** has come to feel that he should not try to continue as our class secretary; he therefore resigned that office on July 13. After serving as our assistant secretary and class agent for a number of years, Herman was elected secretary at our 50th reunion, to succeed Harold Richmond. Since then, even though he was often under considerable physical handicaps, he has done an outstanding job in a position vital to the welfare of the Class. **Ray Dinsmore** and all the rest of us feel that we owe Herman a great deal for his devoted and able service. We hope that, before too long, he will be restored to good health and can resume his usual activities. Pending a decision as to Herman's successor, your assistant secretary is trying to fill in.

Ray Dinsmore, **Leicester Hamilton** and your assistant secretary represented the Class at Alumni Homecoming. Ray came a few days early so that he could attend a reception for Dr. Killian given by the present and former members of the M.I.T. Corporation, and spent most of the weekend with his sister in Tewksbury. . . . **Harold Wilkins** joined us on June 7 for an informal executive committee meeting, to talk over the possible class reunion in 1972. You will recall that, at a class meeting held during our 55th reunion, it was agreed that another reunion in three years should be seriously considered. Ham pointed out that the Alumni Association is agreeable to reunions at other than five-year anniversaries, and that the Institute would provide dormitory accommodations. Accordingly, a letter which Ray has written will go out in the fall to those who attended either the 50th or the 55th reunion—the group most likely to be interested in a 58th reunion. If the responses to that letter are favorable enough, plans for the reunion will go ahead under Ham's direction, and, early next year, every active member of the Class will be given an opportunity to sign up. (Active members include all who received M.I.T. degrees with our class, and all who have given to the Alumni Fund, even though they do not hold Institute degrees.)

Phil Russell wrote in July from his home in Scarsdale, N.Y., that after spending 20-odd years with the First Boston Corp. and then 15 with Mutual Life of New York, he is semi-retired and is president of a mutual fund—which keeps him busy following the market. Since his wife's death in 1967, Phil has lived with his daughter, and keeps in touch with his grandchildren and a great-grandson.

Edward W. Larkin died on November 10, 1970, after a brief illness, in Springfield, where he had lived for 50 years. He was born in Northampton in 1888, and after graduating from Holy Cross College, spent four years with us at the Institute and received his bachelor's degree in Course I. Following some years with F.T. Ley and Co., he established his own contracting business, E.W. Larkin and Co., of which he was the owner at the time of his death. He had also been president of the Building Trades Employers' Association, of Springfield. Ed left one son, Dr. Philip C. Larkin, of White Plains, N.Y.; three daughters, Mrs. John B. Mayotte, Mrs. Donald N. Ryan and Miss Barbara Larkin, all of Springfield; 23 grandchildren, and a great-grandson. His wife, Jessie H. Spencer, had predeceased him. Ed was a communicant of Holy Name Church, and was a member of several laymen's organizations. Miss Barbara Larkin, in a recent letter, said of her father, "His excellent life was profoundly affected by those valuable four years at M.I.T. and in later years he was troubled by certain trends in our institutions of higher learning."

Paul B. Owen died at his home in New York on March 21, 1971 at the age of 79, after a brief illness. He prepared for M.I.T. at Phillips Andover, was with our class during all four years, and graduated in Course VI. Most of his career was in the real estate field in New York, first with a trust company, later with Ivor B. Clark, Inc., and finally with Cross and Brown Co., from which he retired in 1969 as a vice president. At our 50th reunion, which he attended with his wife Marjorie

(who died several years ago), Paul was elected to the nominating and executive committees of the Class. He left three daughters, six grandchildren, and two great-grandchildren.

Rudolph F. Zecha died at the age of 78 on April 3, 1971, in Greenville, Va., while returning from a Florida vacation. He spent all four years with us at the Institute, and graduated in Course VI. In the 20's and early 30's, Rudy was with the Prospect Weaving Co. in Pawtucket and became its treasurer. From 1938 to 1957 he was a supervisor in the cable division of U.S. Steel in Worcester, and lived in Shrewsbury. He retired in the latter year, and in 1963 moved to Cumberland, R.I. His first wife, Mabelle Jameson, died in 1958, and in 1963 he married Jessie Dawson, with whom he came to our 50th and 55th reunions. She survives him, as do two daughters and six grandchildren.

New addresses: Louis D. Charm, Fellowship House, 11450 N. Shore Dr., Lake Ann Village, Reston, Va. 22070; Irving T. Thorton, 99 Bank St., Apt. 5-I, New York, N.Y. 10014.—**Charles H. Chatfield,** Assistant Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

Hello everybody! Here beginneth the first column of the new season, with the hope that you and your families have all enjoyed a pleasant and happy summer. Our annual class cocktail party was as popular and successful as ever, with 38 for cocktails, 29 for dinner and 19 at Bill Smith's after dinner. A good show! The "younger members" of the Class and their families added a lot and were particularly welcome with our hope that they will always join us. Barbara Thomas, really a part of the Class, with her friendly and personable presence added a great deal to the party's success and was a genial hostess. Bill Morrison served a delicious dinner for us at The Faculty Club, led by the Pirate's inspiring "we are happy" cheer and spirit. A great guy! On to **Bill Smith's** later where his lovely sister Florence and his charming guest, Ruth, served us royally. The beautiful structure of this fine class party rests on the firm foundation that good old **Al Sampson** set up years ago. Long may the Class Supreme wave.

Here's news and bits from classmates far and wide. Our Class President and good old friend, **Jack Dalton** was seriously sick in the Peterborough, N.H., hospital and could not attend any of the Alumni Day and class activities. We all missed him. I'm glad to report Jack is much better and recovering steadily and successfully at home. In answer to many messages, Jack writes "I can never forget what our classmates have done to cheer me and make me realize again what it means to have friends like you Fifteeners. The response about my upset has been overwhelming and has touched me deeply. All so cheering and friendly. It's a pleasure to tell them how much I appreciate their interest and concern." Hurry up and get well, Jack. . . . Many cards for our class party came back with regrets—**Alice Anderson** said her trip to Spain and Portugal was fine; **Mary Plummer Rice** was busy with one of her many patriotic duties; **Ruthie (Place) Hickey** asked if she could get free transportation from Pasadena—ah, me! "Age" was the excuse on many replies. We're "getting on". At the suggestion of several classmates, our Boston fall class meeting will be a *lunch* at the Faculty Club on October 15. No more night driving for the long distance men!

The hard and inexorable policy of the *Review* editors in restricting and limiting our notes caused the omission of **Bob Welles'** colorful and interesting description of that horrible Los Angeles earthquake. At long last—here it is: Writing to his sister in Connecticut, just after the Los Angeles earthquake in February, Bob Welles gives an exciting description of that horrible catastrophe: "I will admit it was the hardest shake I have experienced in the fifty years I have lived here. It came in the morning about one minute past six, while I was still lying in bed. The house suddenly started shaking and rumbling so hard I thought there was quite a chance it would fold up. I sleep on the second floor and have a heavy roof of red padre tiles. Not being as agile as I used to be, I stayed put until it was over. Then I sat up, and the first thing I noticed looking outside was green glows from short circuits. On looking around the house, I found nothing more serious than four bottles of liquor shaken off a shelf in the basement and smashed on the floor. Pictures on the walls were all askew, some books shaken off the shelves, and drawers half-open. We continued to get aftershakes all day and several the following day, and two very slight ones this morning. Some were pretty good shakes, too."

Phil Alger was a guest of honor at the 1921 Fiftieth Reunion dinner here and phoned me. He gets around. . . . Our new far distant contributor to our column **Bahjat Abdulnour,** writes from Beirut, Lebanon; after all these years of silence it's wonderful to hear from him. We arranged to have sent to him some maps and photographs of present M.I.T. buildings, and he responded, "You have no idea what pleasure I felt in going over all the M.I.T. photos." Later I wrote him a series of inquiries about Lebanon and the Near East, to which he replied: "We have no wood or lumber for construction work. We have to import same from Turkey, Roumania, Sweden. So all our buildings are stone and concrete. Should you be thinking of the 'Cedars of Lebanon', there are very few trees left, which are preserved as historical souvenirs. The entire forest was felled in ancient times to supply King Solomon to build his temple, and likewise ancient Egyptians carried them away to construct their sailing vessels. As to the height of buildings, up to 1958 the law stipulated the maximum to 22 meters. However, a new law now permits builders to exceed the 22 meter limit, when they recede from the street alignment. Additional height in ratio to retreat from street is a 45° angle. No limit to excess height; property is so valuable you do not generally recede much. I am sorry to state that with continued unrest, bank failures, black-mail and lengthy interruption of work have prevented me from keeping a reserve for my retirement. However, with my pension and collecting old bills, I manage to be comfortable."

While visiting here, **Alton Cook** spent a pleasant afternoon with me and I was glad to see him again. We all missed Fran and **Henry Daley** at our June Party. Henry wrote: "I'm sorry, but we'll have to pass up the annual class cocktail party and dinner this June. We will sorely miss getting together with all our fine friends, the only time we have missed out since this annual affair was first started. Our very best to all my classmates, their wives, and of course Fran and yourself." . . . Congratulations to **Whit Brown** for his richly deserved recog-

nition and reward for his interest, work and contributions to make Marlboro College, Marlboro, Vt., what it is today. A Concord, Mass. (where Whit lives) newspaper had this story: "Building Dedicated to Whit Brown. Last Saturday, April 24, the new science building at Marlboro College in Marlboro, Vermont was dedicated to H. Whittemore Brown of Concord. Mr. Brown is a trustee of the college. The building was financed entirely by gifts and is the culmination of years of planning to provide the ideal facility for the college's intensive science program. In addition to a large laboratory in each subject matter area, the building includes classrooms and small laboratories for individualized study, especially for two students working together and for advanced projects. Mr. Brown who spoke at the dedication ceremony has been a trustee of the college for almost two decades and chairman of the building committee during that time. A former selectman and member of many appointive boards in Concord, his latest service to the community was the long and arduous task of obtaining more parking area both in Concord Center and West Concord. Several Concord friends attended the dedication of the modern, functional science building with its rustic exterior."

George Easter writes that last April 30 they had over three feet of snow and his son walked on snow shoes from the road right onto the roof. "In Massina, four lane highways had given up to snowmobiles and when streets were dug out, the snowpiles at corners were 15 feet high. Sorry to miss the party this year. Give my regards to everybody." Better stick to Florida, George. . . . Virginia and **Hank Marion** had another grand winter in Tucson with beautiful weather and only two rainy days. Hank, as fit as ever, was with us in June but we all missed Virginia. Hank phoned when he was in Boston later in the summer. Swell to hear from him. . . . **Ray Stringfield, Bob Welles** and **Harold Crowell** helped to welcome incoming President Jerome Wiesner to Los Angeles on June 16. Ray says he has not sense enough to retire but doesn't feel like working much, so Margaret and he spend a lot of time loafing up in the Redwoods where he can relax and read. A nice life. . . . When I was in Pinehurst, N.C. in July, I spent a delightful afternoon with Joan and **Bur Swain** at their comfortable house in nearby Southern Pines. Bur took me sightseeing and I was tremendously impressed by the large estates and elaborate golf courses and clubs down there. . . . In June, **Jim Tobey** was in Kentucky and visited the famous Mammoth Cave.

Look where **Bud** "Kozak" **Walker** is and what he is doing. From Bopperd, am Rhein, Germany (of course): "I bought a new Renault 16TS, have a blonde German girl chauffeur and shall tour Europe until October 15, then back to West Palm Beach for the winter." What a life—what a guy! . . . **Vince Maconi** says he is and isn't retired. What does he mean? Marion and he have ten grandchildren, one of whom graduated from Wisconsin in 1971. Another is a freshman at Tercentary College. All the family, old and young are all well and happy. . . . A nice message from **Gil Peakes:** "My activity continues to be mostly in stamps, where I have been studying some oldies for varieties. Outdoors I have been painting the west side of the house and expect to start on the south side soon. The system is to wait until the painting is needed, then do whatever side most needs attention. I missed the New York dinner this year and had hoped that somebody on this end would arrange something. I hope that you and Fran are keeping well and will continue doing just that."

Ralph Hart died July 20 in New York after a long illness. For some time he had been in poor health and failed badly toward the end. He attended all our Five Year Reunions and New York dinners and had always been a liberal and regular supporter of Class and Alumni activities. It was a privilege to attend his services in Boston with Larry Landers. . . . After a long illness, **Carlton W. Eddy** died June 4 at Harwichport, Mass.

Thru Whit Brown, **Marion Whitcomb** sent a very generous check that Herb had bequeathed to M.I.T. Many thanks to her.—**Azel Mack,** Secretary, 100 Memorial Dr., Cambridge, Mass. 02142

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The 55th Anniversary Reunion has come and gone leaving another installment of delightful memories of friends revisited and happy days at the Chatham Bars Inn on Cape Cod. The Class has convened there so many times that it was like an "Old Home Week" and many words of appreciation are due the management. This year, for the first time, the reunion was held mid-week instead of week-end, an innovation that was heartily endorsed by all those questioned. Tuesday, Wednesday and Thursday, June 8, 9 and 10 were this year's dates and similar arrangements were approved for next year.

There were 41 classmates at Chatham and 73 all together. In addition there were five more at the Cambridge festivities who didn't make it to the Cape; the **Tom McSweeneys** and the **Shatswell Obers,** and of course, **Van Bush.** Our efficient and devoted honorary member, **Bob O'Brien,** did himself proud as Reunion Chairman. All the details meshed like a picture puzzle and no missing pieces. The Class is indeed fortunate and gave Bob a vote of appreciation for his dedicated service. His wife, Rose, was able to delegate the family responsibilities to the older children and joined the party for the first time, a charming and delightful addition which has been urged for many years. We think Bob is also responsible for the continuation of perfect weather which has accompanied all our reunions since we can remember.

Several classmates came on Monday to help in preparations for the big-do. **Jim Evans** was on hand to see that the 1916 banner was properly raised at Cottage G, the usual headquarters, and Dolly and **Len Stone** to prepare bulletin boards and binders of exhibits and pictures, pinch hitting for **Harold Dodge,** our greatly missed Secretary. At last reports he was doing well but his doctor wanted him to avoid the excitement and exertion which was inevitable at such a wing-ding. . . . Gladys and **Francis Stern,** our unimpeachable Treasurer, showed up early and, of course, Sibyl and **Ralph Fletcher,** our genial and generous Class President and First Lady, as well as Gypsy and **Cy Guething,** en route to Boothbay Harbor where they spend summers.

Early arrivals on Tuesday began with **Izzy Richmond** who flew his plane down from Boston thru the murk (good navigating) followed by Ruth and **Emory Kemp** from Florida, Gretchen and **John Gore** from Canajoharie, and Gladys and **John Fairfield** from Troy. After that the influx began in earnest which can only be mentioned by name and not necessarily order. Phil Baker, Mary and Jo Barker, Bea and Walt Binger, Bert Boulton, Helen

and Jack Burbank, Phylis and Clint Carpenter, Hildegarde and Jap Carr (who have recently given the J. B. Carr Indoor Tennis Center, an air-supported inflatable structure covering four existing tennis courts), Mrs. H. C. Fisher, Charly Cellarius, Dina Coleman, Hope and Theron Curtis, Frances and Paul Duff, Mertie and Allen Giles (the most newly weds), Grace and Dan Comiskey, Barney Gordon, Maury Holland, Ed Graustein, Freeman Hatch, Mildred and Frank Holmes, Lois and Charly Lawrance, Betty and Charly McCarthy (fresh from six months travelling around the world) Herb Mendelson, Elizabeth Pattee, Dorothy and Dave Patten, Mildred and Charly Reed, Doug Robertson, Frances and Henry Shepard, Betty and Dave Shohet, Mildred and Art Shuey, Emerald and Ken Sully (all the way from California), Frieda and Hi Ullian, Eleanor and Don Webster, and last but not least, Sylvia and Vert Young.

As to the principal events: all dinners and luncheons were events with much socializing and **Ralph Fletcher**'s wine at all tables to make them festive oases. The president's cocktail party on Tuesday evening started the ball rolling and it never stopped. On Wednesday morning there seemed to be a good many classmates milling around so Ralph organized an old-fashioned bull-session at which about 17 classmates showed up around 10:30. Ralph started off with recollections of the travail he went through at the time of our 25th Reunion gift to the Institute which eventuated in the memorial to President Maclaurin, carved into the east wall of the lobby under the dome. . . . Then **Jo Barker** told of his current activities as senior warden of Trinity Church in New York, involving the administration of large real estate holdings and the search for a new rector. . . . **Herb Mendelson** recalled a speech by Robert Kennedy deploring the impression he got in talking to members of the armed forces in Korea that as many as 40 per cent professed no belief in anything. This discussion led into individual reactions to the idea of the existence of something transcendent to man which was generally professed by the group—a rather noteworthy development for a bull-session. Adjournment was about lunch time.

The clambake at the Shore House on Wednesday noon lived up to its reputation; steamed clams by the bushel, all the lobster one could eat, corn-on-the-cob, sweet and tender and watermelon to top it all off. Then, before we dispersed, the class photographer set up his apparatus and arranged the crowd in true professional manner. He also snapped the shutters for several of the classmates so the occasion should be well recorded. . . . **Charly Cellarius** and **Paul Duff** were appointed class photographers and there were many other shutter bugs whose pictures we solicit for next year's album.

The class meeting was called for five o'clock and after a search party was sent out to rouse the officers from their naps, Ralph called the meeting to order and made the introductory remarks in his inimitable manner. . . . **Francis Stern** had planned to appear in ragged shirt, well-worn dungarees and bare feet to emphasize the condition of the finances of the Class but Gladys prevailed and his report was rendered more but not entirely in the formal manner. Copies will be sent to those applying, substantiating the validity of Francis' original plan. . . . **Harold Dodge** sent his Secretary's report to the President who read it in absentia. Highlights of the report follow: Class membership as of May 12, 1971, was 222 and at the 54th reunion it was 234. Attendance at the 54th was 45 including 23 classmates. The resolution regarding campus unrest as reported in the notes last year was restated. Kudos to your Assistant Secretary were expressed and duly appreciated. Regrets at the curtailment of class notes by the *Review* to one page per issue were stated and hope that exceptions would be made under special circumstances such as reunion reporting. Since our 50th reunion until the curtailment, the notes have averaged about two pages per issue, not counting the space taken by pictures. Copies will be sent to those applying. . . . **Charly Lawrance** proposed, and his suggestion was greeted with acclaim, that some notice be given of our desire that the widows of our classmates be with us at reunions. They are greatly missed and considered as de facto members of the Class. It was suggested that the Executive Committee institute procedures to inform them that they are not only welcome but that their presence is urgently wanted.

The next order of business was the class cocktail party and the details of the general sociability overwhelm ye scribe. As an introduction to the class dinner it was indeed beyond description. The previous activities built up to a perfect climax. As to the food and drink, suffice it to say it was pure Chatham Bars Inn than which there is no whicher. There was a head table with people at it but their principal function was to acknowledge requests from the floor. "Stories my mother taught me" (almost—and brought up to date) spouted from all directions, too voluminous to report. . . . **Jimmy Evans** asked the octogenarians to stand, take a bow and tell how come (there were six, names on application). . . . Two classmates had birthdays during the reunion, **Elizabeth Pattee** and **Phil Baker.** Incidentally Phil put all our Sartorions to shame as he had recently been to Italy and acquired raiment to which only the peacock can aspire—darn good looking, too. . . . But **Sylvia Young** provided the piece-de-resistance in her bunny costume complete with ears and a suitable tail. Her search for carrots among the tables roused much good natured commotion. We hear that Vertrees clipped her ears after the show.

This briefs the main events but in spite of space limitations there are other highlights that cry out for mention. The dance music every night till 2 a.m. (I'm told) was in the best tradition for such as we. The piano, accordion and sometimes drums were played by the same talented men we have enjoyed for lo these many years. Also **Allen Giles** played to good effect in the lounge on several occasions and accompanied **Barney Gordon**'s "Old Man River" and other nostalgic pieces from the old M.I.T. song books. As usual the red coats which originated at our 50th and worn on all occasions stole the show from other guests and brought back grateful memories of those responsible.

Your Secretary was unable to attend the 55th reunion but wishes to express his and Grace's appreciation for the letters and multi-messaged cards received from Chatham with the varied wish-you-were-here items from many well-fed reunioners. There were many bits of interest regarding the reunion in the letter from Lois and Charlie Lawrance, thus: "The mid-week dates made for easier driving, which pleased us. Wednesday was cool but clear and sunny, with white caps on the water part of the time. The clambake was at the shore as planned but not right out in the open. Coats and sweaters were in order. The clams and lobsters were really delicious, and some folks even had several helpings." (One sure bet: Cy Guething was there!) "Bob O'Brien was an excellent reunion chairman and we had the pleasure of meeting his wife, Rose. While the class meeting was in progress, some of the ladies sat in front of the 1916 cottage, on the sunny side and 'visited.' We met 'the bride' (Mildred Shuey) whom we have read about in the 1916 column and were glad to welcome her. We expect to see you at the next reunion, for these contacts with friends of 'Auld Lang Syne' are most precious memories and inspirations."

We regret to report that our expert on trend analysis and statistical adviser to Ed Short, Vice President of the Chicago White Sox, **George Petit,** passed away at home in West Hartford, Conn., on June 10. On baseball expectations, he was frequently quoted in Bill Lee's sports column of the *Hartford Courant.* The June 12 issue of the *Courant* mentioned that in 1965 George "started a petition to support U.S. policy in Vietnam. In 1965, Mr. Petit heard a U.S. general in a television interview say that the soldiers in Vietnam needed their country's moral support. A veteran of World War I, he hastily collected a petition with signatures from his neighbors and sent it to the general. Born in Bayside, L.I., N.Y., he lived in West Hartford 30 years. He was graduated from M.I.T. as a civil engineer in 1916, and worked in the research department of the Travelers Insurance Co. 23 years, retiring in 1958. He was a member of the Hayes Velhage Post of the American Legion, West Hartford. He leaves his wife, Mrs. Marie Greiner Petit; a son, George H. Petit of Elmwood; a sister Mrs. Madelon P. Hamilton of St. Petersburg, Fla., and a grandson."

We regret to report the death of Col. **Marcel Gillis** on May 22. Word from his wife said that they had been spending their 27th winter in Florida, both of them in excellent health, but one day while driving, Marcel pulled over to the side of the road and toppled over. That appeared to be the beginning of a two and a half month illness, in which he had six doctors, and nurses around the clock, but all to no avail. Besides his wife he leaves a daughter, Mrs. Martha Restorick,

and three grandchildren in Naperville, Ill., and a sister in Nashville, Tenn. Our deepest sympathy has been sent to Mrs. Gillis.

We also wish to express our deepest sympathy to **Frank Ross** of Naples, Fla. in the recent loss of his wife, Christine. Funeral services were held on July 28 in the old home town of West Hartford, Conn., and we had word from Francis Stern that he was attending.

Now the bell has rung. More items in later notes. Reunion must be seen and heard to be believed. See you next year. Be sure now. In the meantime, write often, even if only a little, to: **Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046 or to **Leonard Stone,** Assistant Secretary, 34-16 85 St., Jackson Heights, N.Y. 11372

Max Seltzer, Mr. and Mrs. J. Howe, Saxon Fletcher, John Kilduff, all class of '18, at 1971 Homecoming

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Regretfully announcement is made of the death of **James W. Doon** on June 23 at Concord, N.H. He had been living for 50 years in nearby Henniker where he had many activities. He was town moderator for 35 years, library trustee, municipal court judge, member of the New Hampshire legislature and later secretary of the Public Utilities Commission. He was a trustee of the New England College in Henniker and a board chairman. He was a veteran of World Wars I and II and a former National Vice-Commander of the American Legion. He is survived by three sons, three daughters and his wife to whom the condolences of the Class are offered.

The sympathy of all of us goes to **Penn Brooks** and his family on the death of his wife Carol. She died August 10 at their Virginia farm home after a lingering illness. Besides Penn she is survived by one son and two daughters. Carol was fondly known to many of the classmates and will be greatly missed. A memorial service was held on August 15 in the Woodland Union Church at Millboro, Va.

We had a good red jacket representation on Homecoming Day on June 7. Those present were the Beadles, Dennens, Dunhams, Dunnings, Hunters, Lewises, Lunns, R. Stevens with singles Ray Brooks, Dodge, Flaherty, Stan Lane and Strout. There was a highly interesting program and the annual memorial service commemorated 15 of our classmates.

June 26 could not have had a more gorgeous afternoon for Charlotte and **Art Gilmour** to celebrate their 50th wedding anniversary at their attractive home and garden at Haverhill, Mass. Among the many friends were the **Chet Ames** and the **Stan Dunnings**. . . . Recently **Ossie Holt** visited briefly in his old home town of Arlington, Mass. He and your secretary took a ten a.m. M.I.T. campus tour. Our guide, a fourth year student, made the tour interesting and worthwhile. Any of you or your friends would find these two-a-day tours enlightening.

A pleasant call was had on Evelyn and **Ray Blanchard.** Ray, as cheery as ever, keeps up one activity—his bank meetings. . . . Belatedly news is passed on of **Dad Wenzell,** taken from an April letter. He retired from the World Bank several years ago but continues to keep his house in Washington. Some consulting chores for the Bank once in a while along with special work for a firm of engineers based in Washington and Baltimore keep him somewhat active. When not in Washington he is likely to be found at the Onteora Club at Tannersville, N.Y. where he has had a summer home for some years. (From another source it is learned that he was president of the Club recently.) His son Tom, a National Audubon Society trustee has a farm nearby. Dad and Zillah haven't been able to get to a Northfield reunion but hope to make it this year.

Every field has its "bossman"—the one who sets the style and makes the rules. In blue grass and early country music the man is Bill Monroe. In the world of blues and blues bands—Chicago blues—the man is Muddy Waters. An interesting book entitled *Bossmen-Bill Monroe and Muddy Waters* well written by James Rooney and dedicated "to my Uncle **Jim Flaherty,** architect, painter, free spirit and friend to young people" comes to hand. . . . **Joe Littlefield** father of 11-year-old Josh, "Black Jack"—I.B.M. player (mentioned in the May notes), seems to have things coming for him. By way of bridging the generation gap he became a great-grandfather this summer. Also, in the Flaherty watercolor drawing as outlined by the April Class letter by Ray Stevens, Joe's entry was drawn. So Joe now has the lovely painting of Walker Memorial. . . . Mentioning great-grandchildren, can anyone even match Helen and **Stan Lane** with their ten of them?

Betty Hulburd was made an honorary member of the Class of 1921 of Exeter Academy in honor of her late husband Phil who taught there for many years. . . . Our honorary member **Don Severance** completed a commendable job in April having been president of the Skating Club of Boston for three years. His club mate is happy to congratulate him on the fine job done whereby the Club is in a stronger position from every aspect. Incidentally Don and Phyl make an attractive ice-skating, dancing couple.

A press conference in June in Washington introduced the Meloy Laboratories Mobile System for Reclaiming Oil Contaminated Beach Sand. Tom and his associates developed this for the Environmental Protection Agency. It is capable of cleaning and reclaiming more than 700 tons of beach sand a day, equivalent to a one mile strip of beach, 32 feet wide and one inch deep.

Word is received of the death of **Alden D. Nute** at Providence, R.I. . . . The July notes recorded the death of **Selden Senter,** brother of Ras. After W.W.I in which Selden served in the Air Corps, he located in Shreveport, La. where he spent the rest of his life. He was president of the wholesale firm of Morrison-Dickson Drug Co. and had many civic interests.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

In early June the Alumni Reunion took place in Cambridge. Among the '18 attendees were the Herbert McNarys, the Clarence Fullers, the Alfred Grossmans, the Tom Brosnahans, the John Kilduffs, the Julian Howes, the Harry LeVines, the Max Seltzers, Gretchen Palmer, Pete Harrall, Sax Fletcher, Nat Krass, and Eli Berman. It was good to have the group together—next year, hopefully, we will have more.

Our assistant secretary, **Len Levine,** recently underwent surgery but is recovering rapidly and ready to resume teaching before these notes reach you. Incidentally, there was a mystery concerning the photo in the June *Review* as to who was in the picture with **Frank Burke.** Frank called Len to chide him at not recognizing himself. It turns out that this picture was taken on the old Charlestown drawbridge in 1918 when Frank and Len were taking a course at the Boston Navy Yard along with 30 others in preparation for a Naval career.

Thanks to Len Levine, here is a short note from **Stuart Caldwell:** "This is in answer to yours of April 28. I had to be away in May and delayed writing you hoping something worth reporting would happen. But it never does, you know. I

can, however, report that my 'youthful attractiveness' as you put it, fled long since and I regret that I was never the 'beautiful female' in any show. It has been nice to hear from you, particularly in such flattering phrases, but you better leave me out of the Alumni Magazine as the only world-shattering items are that I am Treasurer of my church and that I am studying the complicated Chinese language." Incidentally, what is this business of studying the complicated Chinese language? How about some details.

At the risk of seeming immodest, Selma and I can report that we were in London, Normandy, Norway, and Belgium for most of July. We found London much cleaner than it was when we saw it on our first visit in 1955. Pollution has been reduced to a minimum. Le Havre and Rouen have been restored with new factories since their damage by bombing in World War II. Our trip through Norway was most interesting for we were on a 12,000-ton ship for two weeks cruising along the coast going in and out of the fjords from Bergen to the North Cape, well above the Arctic Circle. The towering and rugged mountains rising abruptly at the shore's edge made for breath-taking scenery. Here again, most of the towns and cities were destroyed by the Germans as they retreated in World War II and now reconstructed largely with Marshall Plan money. Our last week in Belgium was indeed in sharp contrast—flat land with many canals, but all the land produces crops or is used for cattle grazing. We liked Brussells and were charmed by Ghent and Bruges. The high point was a visit to Four Chateaux, opened this year for the first time to visitors.

Many of you recall the one-day reunion at Endicott House in Dedham last November. A repeat performance is scheduled for October 24, news of which you have already received in the mail. We hope to have more of you attend this most pleasant get-together.

Elizabeth and **Julie Howe** leave Sept. 1 for a month in Italy. We had a nice phone conversation recently with Dorothy and **Ed Rossman,** who are now in South Paris, Maine and are scheduled to go to Tucson, Ariz. about November 1. **John Kilduff** is being honored for his contribution to Jackson Memorial Research Center in Boothbay Harbor, Maine—more details at a future date.

We record with sorrow the deaths of **Clarence Hanscom** and **George Oxley.** We were fortunate to have received George's biography recently which appeared in the May issue of the *Review.* I invite you all to send me your own biography—no matter how humble it may sound to you, it will be interesting to all of us.

Craig Hazelet dropped me an announcement of his retirement as managing partner of Hazelet and Erdal, but will continue as consultant for them in Louisville, Ky. . . . **Jack Poteat's** letters are always interesting. He is indeed a keen observer with an intense curiosity about what goes on around him. In my opinion, these are the greatest dividends you can receive from matriculation from M.I.T. Jack writes: "The first time I went to Bunker Hill Monument was when someone came to Boston and wanted to go. Wherever we live, it is always the nearby attractions that we neglect in favor of the more distant ones. In our adopted state of North Carolina there are so many places of interest—geologically with the highest mountain east of the Rockies, to the Outer Banks, a strange sandy formation along the Atlantic; historically from the earliest English settlement on our shores including the Lost Colony, through the Revolutionary War period when one of the few sources of supply for Washington at Valley Forge was an inlet in the Outer Banks which the British couldn't blockade, and the battles of Cowpens in South Carolina and King's Mountain in North Carolina which blocked the reinforcements that were coming to the aid of Cornwallis, and so forced his surrender. The first tea party when the women refused to use British tea, took place in North Carolina. The first lighthouse on the Atlantic coast was built at Cape Hatteras under the pressure of Alexander Hamilton, and the daughter of his duelling-slayer was lost in the sea, off Hatteras. In World War II German submarines cruised off the North Carolina Coast sinking many tankers. But enough of North Carolina history. You see your illustrious state of Massachusetts with all its glorious history is matched in many ways by North Carolina even to the Indian campaigns the end of which was signalled by a treaty between Governor Tryon and Chief Sequoia of the Cherokees.

"So we went to the Outer Banks in April as well as to the early capitals of the state when it was a royal colony in the 1700's. Bath, the oldest town, where Blackbeard holed in after a royal pardon which he paid no attention to, since he and the royal governor were in cahoots, sharing the booty of his piracy. It took a British naval lieutenant to kill him in hand-to-hand combat in 1718. Got enough? Come to North Carolina and see the one national park that is visited by more people than any other. And stop off and see us on the way. Cordially, Jack."

New addresses are as follows: George Y. Cannon, 105 East So. Temple 214 Salt Lake City, Utah; Saxton Fletcher, Cloverly Farm, Greenfield, New Hampshire; Douglas Buchanan, 122 Deleon Road, Cocoa Beach, Fla.; Edward N. Little, Box 305, Friendship, Maine; James D. Newman, 1600 S. Eads Street, Apt. 424S, Arlington, Va.; Sumner K. Wiley, RFD 1, South Harpswell, Maine; James A. Flint, 320 Ranch Gallatin Gateway, Mont.; John W. B. Kennard, 8-0 Sussex Way, Jamesbury, N.J.; Frederic Lane, Stoneway Rd., Box 261, Wakefield, R.I.; Henry C. Stephens, 435 Seaside #1406, Honolulu, Hawaii.—Submitted by **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, Mass.

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Attendance was sparse at Alumni Homecoming last June, as more or less expected, a year after our glorious 50th. Present and accounted for were Esther and Frank Bradley, Ruth and Elbridge Wason, Barbara and Bill Dewey, Betty and Al Burke, Beth and Ed Ryer, Mina and Perk Bugbee, Dave Fiske and, of course, your secretary and his Amy.

Our lively and spirited classmates continue to make the most of life and living. Betty and **Norrie Abbott** spent most of the summer in Spain and Portugal. They particularly liked the Algarve and its celebrated sunshine, had a speedy hydrofoil trip to Tangiers where Betty was photographed on a camel with a snake charmer's cobra as a necklace. (Send us a print, Norrie, and we'll publish it in the *Review*). The Abbotts report a happy meeting with Marge and **Jack Crowley** at Reed's Hotel in Madeira. Norrie thinks he has sold the Crowleys on a visit to the annual Mexican Fiesta next winter. Marge and Jack are going from Madeira to Lake Como and Yugoslavia, then back for their annual visit to Colorado in August and then, nothing daunted, to Portugal, Spain and Sardinia before settling down in Jupiter, Florida. "We are well and happy," says Jack. More power to them.

Dusty Miller and Clotilde explored Tahiti and adjacent islands last winter and spent some time in the hinterland of Mexico. Dusty reports that they have enjoyed a number of gatherings with Margaret and Skeetz Brown. "Our 1920 blazers were the cynosure of all Phoenix society," says Dusty, who adds, "Health good! Spirits good! Clotilde's first exposure to M.I.T. culture at the 50th was a huge success, as was my first visit to the Institute in many years." . . . A delightful letter from our favorite co-ed, **Dorothea Rathbone,** who expresses lively interest and enjoyment in her college-age grandchildren and says that the best news of all is that their father will be settling in New England after two years in Hawaii. Dorothea explains her absence from alumni day last June because she was recuperating from a dislocated shoulder caused by a fall in the Old North Church of Boston. Says Dorothea, "I still think often of the 50th—what a work of art and achievement that was!" God bless you, Dorothea. Keep well, now, and watch your step!

Another classmate who missed the June reunion after many years of faithful attendance was **Frank Badger.** He writes that Winnie's health prevented her from making the long trip from Hollywood, Fla., although she is better now. . . . A welcome note from **Hank Caldwell** of Sarasota says, "My main hobby is sailing and keeping my sloop shipshape and Bristol fashion, also instructing the U.S. Power Squadron course in sailing." . . . Your secretary had a most pleasant visit with Olive and **Lyman Whitten** who were up from Washington to visit Lyman's brother, Francis, '14. We are happy to report that the Whittens appeared in the best of health and spirits.

Word has been received from **Bob Tirrell** of Englewood, N.J., 140 Meadowbrook Rd., about the death of his beloved wife, Edith, after a long illness. I speak for the entire Class in offering sincere condolences to Bob.

Class of 1921 at its 50th Reunion, June 1971

Recent address changes include those of Jesse Doyle who now lives in Dublin, N.H., P.O. Box 94; and Richard Soderberg who resides on Nantucket Island, P.O. Box 23.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Greetings and a hearty welcome to our 51st season around the friendly fireside of the Class of 1921. We're still on cloud nine celebrating the latest "firsts" achieved by the Class. We had the largest number of men, of women, and total attendance of any M.I.T. 50th reunion for our fun-packed five-day party centered in Cambridge last June. Resplendent in cardinal blazers adorned with silver gray '21 numerals and M.I.T. seal—including the two most distinguished members of the Class, **Howard Johnson,** Chairman of the Corporation, and **Jerome Wiesner,** President of M.I.T. —we enjoyed every minute of the interesting and varied program which had been laboriously put together over the last five years by Reunion Chairman **George Chutter** and his committee.

We owe sincere thanks to these classmates and to the M.I.T. administration and staff, whose red carpet treatment afforded such warm and friendly hospitality. To all who contributed to the program and those who participated in it go the best wishes and deep gratitude of your officers and committeemen. Class President **Ray St. Laurent,** Vice President **Irv Jakobson** and your Secretary-Treasurer extend particular appreciation for the recognition accorded their half-century of class labors and the cordiality of those letters you wrote for their gift albums of '21 memories.

Welcome guests

We were happy to greet, among Institute friends attending various reunion functions, Professor and Mrs. C. Stark Draper, Professor and Mrs. Philip L. Alger, Professor Karl Wildes, Don and Phyl Severance, Fred and Betty Lehmann, John and Anne Mattill, Ken and Ann Brock, Brenda Kelley, Panos and Eleanor Spiliakos. Howard and Mrs. Johnson were gracious reception hosts at the President's home and interested attenders at a '21 dinner with Jerome and Mrs. Wiesner at which the incoming President was presented his certificate of membership in our Class. No one will ever forget the luncheon addressed with such sincerity and wisdom by those two beloved mentors of our student days—Van Bush and Warren Lewis. Tech night at the Pops, the Alumni buffet and other Homecoming '71 events provided more opportunities for meeting friends in the closing hours of the reunion.

Class chronicle

At the Class Banquet, the nominating committee comprised of **Sumner Hayward,** chairman, and **Phil Coffin, Al Lloyd** and **Bob Miller,** renamed **Raymond A. St. Laurent** as Class President; **Irving D. Jakobson,** Vice President, and **Carole A. Clarke,** Secretary-Treasurer, were voted into office also. Elected as Co-Chairmen of the 55th Reunion were **Edouard N. Dubé** and **Edwin T. Steffian.** Continuing in office: **Ted Steffian** and **Sumner Hayward,** Assistant Secretaries; **Ed Dubé** and **Ed Farrand,** Class Agents; **Bob Miller,** Photohistorian; **Al Lloyd** and **Ed Dubé** Interim Reunion Chairmen, and **Chick Kurth,** Alumni Council.

Each lady received a memento of the occasion. Besides the albums of class letters, Ray, Jake and Cac received sets of M.I.T. seal blazer buttons. Special awards recognized **Sam Lunden** for coming the longest distance; **Elmer Campbell** for the most progeny and **Phil Coffin** for the youngest child. **Chick Knight,** golf chairman, gave prizes to **Munnie Hawes** for coming the farthest to play; to Elma and **Don Morse** as the youngest bride and bridegroom on the course, and to Marion Knight for low gross. The entire Reunion Committee was recognized—**Ed Dubé, Bob Haskel, Sumner Hayward, Mel Jenney, Chick Knight, Al Lloyd, Bob Miller** and **Ted Steffian.** Citations bearing M.I.T. seals went to **George Chutter, Paul Rutherford** and **Royal Wood,** respectively Chairman, Vice Chairman and Secretary-Treasurer of the Reunion Committee.

Maxine Clarke, who is a professional artist, performed a surprise presentation to Helen and **Ray St. Laurent** of a pastel portrait she made of them. It was then hung in a display room together with a series of individual pictures of members of the Class, the late **Bill Ready**'s collection of Camp Technology photos, **Phil Nelles'** panorama of the '21 S.N.T.C. Unit, pictures of earlier reunions and various '21 memorabilia including 50 years of Class News from *Technology Review,* old *Techniques* and other historical items.

Bob Miller gave the class history in movies and slides on two evenings. He also introduced classmates who gave personal recollections of interesting events in their lives. Speakers included **Elly Adams, John Barriger, Phil Coffin, Irv Jakobson, Harry Junod, Sam Lunden, Bill Sherry** and **Saul Silverstein. Mel Jenney** read a poem he wrote for the occasion. Copies of the group pictures taken of reunion attenders—one with and one without the ladies—have now been mailed to all who were there. If you are interested in having one color photo of all those specials taken by **Buck Buckner,** write to **Robert F. Miller,** 3386 Chiswick Ct., Silver Spring, Md. 20906. Ask Bob for instructions if Buck did not get your picture.

Special events

Robed and given choice seats on the dais at Commencement, members of the Class had the honor position in the academic procession under the leadership of **Irv Jakobson** as Class Marshal. The stirring address by **Howard Johnson** and the inspiring invocation by the Reverend John Crocker, Jr., Episcopal Chaplain, have already been referred to in the *Review.* Among the 1240 degrees at this 105th Commencement were those of S.B., Course I, and S.M., Course XV, awarded to Thomas H. Derby, 3rd, son of Thomas H. Derby, Jr., '43, and grandson of **Thomas H. Derby,** '21, of Lawrence, Mass. As speaker for the Class of '21 at the commencement luncheon, **Gus Kinzel** led a rising salute from '21 to '71. He suggested graduates give an employer what is wanted, within the limits of his willingness to pay for it, and tell him the alternatives he could have if willing to pay for them.

Jewish religious services in the Chapel were led by M.I.T. Hillel Rabbi Herman Pollack with **Saul Silverstein** as guest speaker. Saul conducted a world trip to numerous foreign synagogues he had visited. The Reverend Dr. **Williston Wirt** prepared the entire service and came all the way from his home in Claremont, Calif., to be the worship leader for the annual Memorial Service for M.I.T. Alumni in the Chapel on Homecoming afternoon. **George Chutter** authored the opening prayer. Memorialized, among others, were

the 29 members of the Class of '21 whose passing was reported in these columns since Homecoming '70. Buses took our reunion group on a tour of Boston; to Lexington and Concord, where our own "redcoats" crossed the famous bridge; and to Hugo's Lighthouse, Cohasset, for a whopping shore dinner.

Class giving

At the Homecoming luncheon, 50-Year Gift Chairman **Irv Jakobson** presented **Howard Johnson** with a portfolio recording a cash gift of $710,580 from 73 per cent of the current roster of the Class, and bequests conservatively estimated at $985,000 for a total of almost $1.7 million. Jake noted there was a string attached—a mooring line for an eight-oared shell which former '21 oarsmen then uncovered to view. The shell and its separate fund, providing for replacement every five years, were also the gift of the Class. Ruth Jakobson brought forward a bottle of champagne—Piper Heidsieck, for those interested—which Helen St. Laurent and Maxine Clarke successfully broke over the bow of the "Class of 1921" on a steel bar held by two oarsmen. Besides **Irv Jakobson,** the first varsity crew captain, former crew members participating were **Ted Steffian,** first crew manager, **Dayton Brown, Ed Delany, Bob Felsenthal, Gene Hardin, Bob Haskel, Munnie Hawes, Al Lloyd, Don Morse** and **Al Wason.**

Reunion roster

Of the 216 present in June, attending stag were: Willard Brolin, Bill Brown, Harry Butters, Ed Chilcott, Jack Healy, Algot Johnson, Harry Junod, Brenda Kelley, Gus Kinzel, Ed MacDonald, Joe Morrell, Alan Osbourne, Jim Parsons, Herb Reinhard, Ace Rood, Bill Sherry, Saul Silverstein, Eric Smith, Ted Spitz, Hank Taintor, Al Wason, Joe Wenick, Jack Whipple.

Attending with wives: Elly Adams, Wally Adams, Bob Barker, John Barriger, Tom Bartram, Mich Bawden, John Bowman, Ilsley Bradley, Charlie Breed, Dayton Brown, Buck Buckner, Elmer Campbell, George Chutter, Cac Clarke, Phil Coffin, Asher Cohen, Larry Conant, Ray Cooper, Brace Crawford, Percival Crocker, Josh Crosby, Jim Cudworth. Also Elmer Davis, Ed Delany, Ed Dennison, Sam Drew, Ed Dubé, Bob Felsenthal, Ben Fisher, Frank Flaherty, Al Fletcher, George Gokey, Harry Goodman, Henry Hallett, Carl Hammond, Gene Hardin, Mahlon Hartley, Art Harvey, Bob Haskel, Phil Hatch, Don Hatheway, Munnie Hawes, Sumner Hayward, Ed Haywood, Roy Hersum, Dug Jackson, Irv Jakobson, Jimmie Janes, Mel Jenney, Howard Johnson, Harry Johnson, Phil Johnson, Herb Kaufmann, Dana Kepner, Chick Knight, Bill Knoepke, Chick Kurth, Al Lloyd, Bill Loesch, Sam Lunden, Don McGuire, Dick McKay, John Mahoney, Lou Mandel, John Mattson, Bob Miller, Ed Molloy, Don Morse, Phil Nelles, Leo Pelkus, Charles Pool, Ed Praetz, Helier Rodríguez, Paul Rutherford, Ray St. Laurent and guests Ted and Maria Boufounos, Sumner Schein, George Schnitzler, Steve Seampos, Rufe Shaw, Ted Steffian, Horace Tuttle, Vivi Valdés and son, Viviano, Al Wakeman, Bill Wald, Al Wechsler, George Welch, Whit Wetherell, Frank Whelan, Jerome Wiesner, Ev Wilson, Dick Windisch, Will Wirt, Harry Witherow, Royal Wood and Ed Wylde.

Postscript

We've eliminated other news to tell you of the Finest Fiftieth for those who managed to "Join '21 in 'Seventy-One!" Now send us your news of travel, family, and maybe photos, slides or movies for showing in 1976! Write now!—**Carole A. Clarke,** Secretary, 608 Union Lane, Brielle, N.J. 08730; **Edwin T. Steffian,** Assistant Secretary, Steffian, Steffian and Bradley, Inc., 19 Temple Place, Boston, Mass. 02111; **Sumner Hayward,** Assistant Secretary, 224 Richards Rd., Ridgewood, N.J. 07450

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You won't believe the truth about our beautiful Buffalo weather of 77 degree average temperature, very little rainfall, and a Lake Erie temperature of 72 degrees. The swimming, sailing and golfing can't be better. As these notes are being written they will be frequently interrupted by practice rounds at Cherry Hill Club in adjacent Canada, just a 22 minute drive from this Buffalo office. And our home on Lake Erie, with accompanying Sunfish is only ten minutes farther on. To enjoy this, there is always tomorrow—always tomorrow—always tomorrow. . . .

The Homecoming at M.I.T. in June was applauded by many of our classmates. The enjoyment included Tech Night at the Pops followed on Monday by the usual academic stars, the traditional Alumni luncheon and a later reception for Dr. Killian. Class presidents served as ushers for the Killians, Johnsons, Wiesners and Grays. Those from our class attending included Madeline and Parke Appel, Edward L. Bowles, Warren T. Ferguson, Mr. and Mrs. J. Gordon Campbell, Mr. and Mrs. Saul J. Copellman, Mr. and Mrs. Oscar H. Horovitz, William L. Hyland, Mr. and Mrs. Abbott L. Johnson, Julian Lovejoy, Mr. and Mrs. Theodore T. Miller, Fearing Pratt, C. Randolph Myer, Samuel H. Reynolds, William W. Russell, Roscoe E. Sherbrooke, Mr. and Mrs. Dale Spoor, Mr. and Mrs. Karl L. Wildes, Charles H. Williams and Yardley Chittick. They have all promised to get out the Big Count for next year's 50th reunion. Gifts of dollars and number of donors are piling up constantly so that we hope to set a new class gift record in June 1972.

Dale Spoor wrote regarding his interesting experiences as Class Agent working under the old theory that interest in a project follows the money, and financial backing follows increased interest. He has corresponded with many classmates. . . . **John Vaupel,** who is permanently situated in Boothbay, Maine, advises he had a visit from Madeline and **Parke Appel.** He is happy with the ecological benefits of this area of the country. . . . **Warren D. Sherman** of Farmington, Conn. joins many others in discussing attitude toward students at M.I.T. He has some extremely constructive and positive ideas with which most of us agree. He believes that some good will come from this interchange of thinking and is supporting the Alumni Fund on the basis of a future and stronger M.I.T. **Roscoe Sherbrooke** extends his constant support to the Class and is going to share more generously after his next lottery ticket pays off.

A letter from **J. Gordon Campbell** to Dale Spoor tells of his apartment in Southbury, Conn., and his association with classmate **Edwin H. Koehler** who lives in Oxford. Gordon spends the summer in the Poconos and has many outside interests. . . . **Edward A. Ash** spends six months of each year in Florida, near Homestead and six months in Detroit. He will be happy to visit with any of us at either place. . . . **Reginald S. Hall** of Norfolk, Conn., has written of his travels to foreign countries during the past ten years. Ziellah and Reg are considering living permanently in the south at their winter home. They are also considering a South Carolina location which is near their present winter house. He hopes that classmates travelling near Tryon will drop in. . . . **Albert L. Sargent** of Melrose, Mass., retired from the Philip Cary Co. and immediately started to work with their distributor, The Eastern Refractories Co. Frances and Albert joined a university tour last year to Tokyo, Kyoto, Osaka, Taiwan, Hong Kong and Bangkok. They flew back to Hawaii in a 747 jet under very comfortable conditions. Last December they attended the annual conference of Health, Welfare and Pension Fund directors in Honolulu and this December their conference will be in Miami. This spring they flew to Acapulco and then visited Taxco and Mexico City. They will be with us at the 50th following the example set by his father who attended his 50th at M.I.T. in 1942.

It was great to receive a complete letter written on a post card from Madeline and **Parke Appel** from Barcelona, Spain. They flew to Madrid in June to visit their daughter Joan and continued to her summer place in Malpica, after which they went on to Malaga, Seville, Cordova, Anteguera and Granada. They drove to Salamanca, Ciudad Rodrigo, Lisbon, then north to Porto staying at Spanish parados and Portuguese posados which are modernized royal castles and hunting lodges. Parke promises to act promptly on final preparations for our 50th reunion. . . . Our assistant secretary, **Oscar Horovitz** showed one of his recent films on Indonesia in June at the meeting of the Boston Stein Club at Endicott House, Dedham, Mass. Some of his other prize-winning documentary films have been of the Ringling Brothers Barnum and Bailey Circus, the Ice Follies and the musical comedy, "Follow the Girls." He will speak in Niagara Falls around the middle of October. . . . **Joseph Greenblatt** now lives at 2100 S. Ocean Dr., Ft. Lauderdale, Fla. He hopes to see local classmates. . . . Professor **Albert P. Powell** is now a member of the M.I.T. Club of southwest Florida. He is enjoying a mobile home in Paradise Bay Trailer Park. He and Mrs. Powell are busy with church work . . . **Edward J. O'Connor** is still active in business as president of Granite State Asphalt Co. in Manchester, N.H.

He spends the winter at Del Ray Beach, Fla. He has 13 grandchildren, enjoys travelling and has an eleven handicap in golf—WOW!

Clift R. Richards is relaxing at Sylvan Shore, Mt. Dora, Fla. . . . **Norman J. Greene** heard Dr. Killian in May at the Union League Club of Philadelphia. He saw **Don Carpenter** of West Chop and W. Robert Barker '21 who lived in Buffalo for many years. . . . **Norman L. Apollonio** of Camina, Calif., writes remembering **Ward E. Shearer, Howard Simons, Andrew LaPenta** and R. Aaron. Norman taught chemistry for a time and then math. He pointed out the seven sections of a cube, noting that a cube spun on a diagonal axis forms cones. He reads the Puzzle Corner in the *Review* and the Class Notes. He is living on an old gold mining claim but his action picture would be of a man sawing wood as he is a fruit farmer. If the price of gold increases he may cash in on the residue of the mines. . . . **C. Lauren Maltby** of Sierra Madre, Calif., assures us that he will be on hand at our 50th. We will check to see if his hair is as blonde as it was in 1922.

We extend the sympathy of the Class to the families of **William A. Hoops** of Auburndale, **William K. Taft** of Akron, Ohio, **Aaron H. Radin** of Malden and **Henry M. Schley** of Jacksonville. We send special greetings and sympathy to the family of **Chester Greening** of Westport, Conn. He enjoyed his retirement years, keeping active in local movements and planned to attend our 50th next June. He will be greatly missed by his many friends.

Among the changes of address received are those of Alfred Abboud, Algonquin, Ill.; George P. Anderson, East Flat Rock, N.C.; David R. Shotwell, Reading, Pa.; William W. Harris, Pompano Beach, Fla.; Roland L. Smith, Del Ray Beach, Fla.; Percy B. Bass, Tequesta, Fla.; C. Ford Blanchard, Point Pleasant Beach, N.J.; Harvey E. Brown, Upper Montclair, N.J.; William A. Clark 2D., Rockville Centre, N.Y.; Harrison D. Folinsbee, Cambridge, Md.; Charles G. Malcolm, Toronto, Canada; Van Dorn C. Smith, Woods Hole, Mass.; James M. Waechter, Hollywood, Fla.

Your secretary and roommate will be in Las Vegas in October to invest Dollars for the 50th. We hope this operation will show astounding results!—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203 . . . **Oscar Horovitz,** Assistant Secretary, 31 Montrose St., Newton, Mass. 02158

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Professor **Milton E. Parker** has sent me copies of interesting correspondence between himself and a fellow alumnus, both of whom have had experience in industry and education. With Parker's permission I quote herewith a few paragraphs from his letters, which may be of interest to some of his classmates and possibly may stimulate ideas from them. Regarding the present situation at M.I.T., Parker's words are as follows: "Although violence may have subsided, there is apparently a deep sense of frustration among students and faculty. The alumni have been woefully negligent in not more actively participating in solving some of the incidental problems. A stool requires three legs in order to sustain any burden. Two legs are obviously inadequate just as students and faculty without alumni cooperation are betrayed! Until the M.I.T. clubs across the country unite and make their presence felt in councils in Cambridge, you can expect more unrest. The faculty is composed of highly educated intellectuals for the most part. The students are earnest and anxious to be heard and heeded. However, in comparing 100 of the faculty with 100 captains of industry, I will give you odds that the latter group will prove the more intelligent. There are too many ultra-liberals on university faculties today who could never meet a payroll nor submerge their egotistical whims in the interest of their fellows."

Herbert L. Hayden, general chairman of our forthcoming 50th reunion committee, has circulated a letter to the class officers and the members of that committee, which outlines the program in general terms and requests suggestions from the committee members. I am sure he would welcome any ideas from the general class membership. His address is 942 Main St., Lancaster, Mass. 01523. A paragraph from Herb Hayden's letter is as follows: "I also have information relative to the jackets that we will want to purchase. As I understand it the Alumni Association will send to all members of our class, at the proper time, cards requesting data relative to sizes etc. We will determine the colors desired. They are made in Boston and an average cost might be in the neighborhood of $50."

For what it may be worth, your assistant secretary records here a few thoughts in regard to jackets. I have just returned from a four day 50th reunion of my wife's class at Wells College on Lake Cayuga. For this occasion some of the girls had made attractive, colorful, large print name tags in class colors, suitable for both men and girls. The total cost of this reunion for both my wife and me was $60.—excluding the cost of driving from Essex to Aurora. (There were no class jackets of $50. each but all the alumnae present knew that the 50 year girls and their husbands were solidly united.) While I know that jackets at M.I.T. are traditional over a few years and that they would not have been adopted without deliberate forethought, I regard them as something of an extravagance for a single occasion. They are in a sense, "show-off" pieces and do not reflect the tendency of either my wife or me. I doubt whether there is any man in our class who could fit my wife into a red (or other bright) jacket against her wishes. If both of us are expected to wear them, the cost would be about $100 which could well be used in other directions at any reunion. There is doubt that every man and girl at the reunion would wear such a jacket, and it might be embarrassing to those who might not wish them. This difficulty would be avoided by having moderate, neat, colorfully decorated name tags for both men and girls, which would not only be attractive but which would also have a utility value. In making this comment I can hear some of my classmates from undergraduate days saying "Pennypacker is still the same old Penny-pincher he used to be." If you are one of these, may I remind you that on class day I was voted to be the man most likely to succeed in business but in the light of the illustrious performances of many of you since graduation, I have certainly not fulfilled this prediction.

It is with regret that I report the passing of our following classmates: **Edwin H. Arnold,** on January 14, 1971; **Charles H. Toll** on June 12, 1971; **P. Y. Tang** at the Hong Kong Sanatorium and Hospital on June 17, 1971.

The following changes of address have been received recently: Alfred E. Perlman, 405 Davis Court, San Francisco, Calif. 94111; Earl D. Brown, 2259 Nugent Rd., Lummi Island, Wash. 98262; E. Bartlett Cocke, 402 Castano, San Antonio, Texas 78209; William E. R. Covell, Del Mesa Carmel, Carmel, Calif. 93921; Clifford P. Swaine, 9 Linden St., So. Hamilton, Mass. 01982; Daniel B. Coleman, Box 34, Alden, Mich. 49612; Morris Falk, 9119 Medill Ave., Franklin Park, Ill. 60131; John J. Gray, R.D. 4, Box 364, Easton, Md. 21601; Atherton Hastings, 614 Paxton Rd., Florence, Ala. 35630; W. Gordon Hughes, Box C-906, New Bedford, Mass. 02741; John V. Janes, Petrolite Corp., Rm. 1600, 506 Olive St., St. Louis, Mo. 63101; Lucian F. Jenness, 1700 West Ave., S E4, Jackson, Mich. 49203.

At the Alumni Homecoming, the following class members were present: Horatio L. Bond; Mr. and Mrs. John E. Burchard; Mr. and Mrs. Miles N. Clair; Mr. and Mrs. Robert Colburn; Mr. and Mrs. E. Louis Greenblatt; Mr. and Mrs. Howard L. Cobb; Mr. and Mrs. Richard H. Frazier; Mr. and Mrs. Delbert W. Kendall; Mr. and Mrs. Elliot P. Knight; Mr. and Mrs. Howard A. Lockhart; Mr. and Mrs. George Rowen; Mr. and Mrs. Julius A. Stratton; Mr. and Mrs. Philip S. Wilder.

Congratulations to **Eugene V. Ward,** who reached his 89th birthday on February 14, 1971. . . .A note from **George W. Bricker** states that he expects to move to South Chatham, Mass., in the near future. . . . **Arne H. Ronka** writes that since his retirement from civil service in May 1970 he and his wife have visited California, Michigan, Kentucky and Florida. They spent last summer at their Gloucester, Mass. home. They have three sons—all veterans, three lovely daughters-in-law, and four lively grandchildren.—**James A. Pennypacker,** Assistant Secretary, Long Hill Rd., Essex, Conn. 06426

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The primary long-range project of the Class is build-up of our 50th-Year Gift. After months of study, **Jack Hennessy,** Chairman, and his committee put in your hands a superb brochure and letter on the Reunion Fund. Even the postage stamps were environmental reminders. May I say that each day brings to me an instance of the absolute need of a laboratory and group of men to determine our real ecological problems, separated

Kenneth A. Roe, '41 (left), President of the American Society of Mechanical Engineers presents Luis A. Ferré, '24 (right) the A.S.M.E.'s Life Quality Engineering Citation in recognition of his leadership and service as governor of Puerto Rico.

from political hogwash and unknowledgable "do-gooders." Our economy cannot possibly absorb billions of dollars of nonproductive capital on questionable antipollution ventures.

Alumni Homecoming on Sunday, June 6, brought about ten couples together for the buffet dinner and Pops concert. We were delighted to have **Betty Kane** as our guest. About the same group attended the more serious events of Monday, among which was the impressive Alumni Memorial Service in the Chapel. Twenty-one classmates were remembered, including our sadly missed **Chick Kane.** President Johnson, in his current capacity, bid us adieu in a luncheon talk. President-elect Wiesner summarized the panel's "Great Debate" and the day was climaxed by a lively reception and farewell for Dr. and Mrs. Killian.

Warren Henderson, '33 writes that the 1971 Mexico City Club Fiesta was attended by **Nish Cornish,** Mexico City; **Charles MacBrayne,** LaSalle, Ill.; **Atherton B. Weston,** Phoenix, Ariz. and **Rutilio Torres-Saravia,** Mexico City. The latter sent your scribe a note in July from Guadalajara enclosing a snapshot taken during April in Australia ("the land of very friendly and rich people"). Rut has lost the trim facial look of his *Technique* picture, but gained the fullness of a happy, prosperous mining engineer, retaining most of his curly hair. I was able to distinguish him from the sizeable koala in his arms. He advises that the animal drinks very little water and feeds only on eucalyptus leaves. We are not familiar with Rut's dietary habits.

Jimmy Doolittle sends a nice note from an office in Los Angeles stating that since he has retired from Shell Oil he does not get East as frequently and misses visits with campus colleagues although occasionally crossing paths with some. . . . **Luis A. Ferre,** the distinguished and frequently honored Governor of Puerto Rico, recently received a "Life Quality Engineering Citation" from the American Society of Mechanical Engineers at the A.S.M.E. Regional Administrative Conference in San Juan. The award recognizes Luis' leadership in the industrialization of Puerto Rico, leadership in civic responsibility and service to the public through governmental service, all of which have materially improved the well-being of his people. . . . About the same time (Sunday, June 13), **Clint Conway** and Allora in Clearwater, Fla. were watching an Educational TV program, via satellite, when the Governor appeared to talk on humanity in a technological world. Clint was so impressed by his logic and sincerity that he sent a letter of appreciation; and, suggests that we might obtain a film to present during our 50th Reunion as a highlight of 1971. Clint has taken on a job with a senior citizens housing project in Clearwater negotiating leases for 200 apartments to be completed by January, but in the meantime will spend two months in Europe learning how. A man of ideas, he suggests a Winter Florida Fiesta in Tampa.

Paul Cardinal and Lorene have conceded that Hoffmann-LaRoche vitamins are not as potent as Florida sunshine, so will absorb same at 707 Port Side Dr., Naples, Fla. 33940 after September first. . . . Going in the opposite direction are **Ed Moll** and Rene abandoning their apartment in Sturbridge, Mass. for their renovated domicile on Burkehaven Road, Sunapee, N.H. 03782.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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Our column this month is largely concerned with comings and goings. A brief word was received from **Frank Foss** of Cranston, R.I. who apparently visited Holland in time for pictures of the Tulip Festival. He says that he is going to go everywhere else first so as to leave 1975 free—a good thought for all of us.

We have a nice long letter from **Henry Sachs** of New York about a trip to the Near East. The following outlines the places visited with interesting comments: Teheran, a fantastic city with traffic problems second to none, caused by 18,000 taxicabs and no regard for rules; crown jewels and anthropological museum the places to see, followed by Shariz, the city of roses, and nearby Persepolis and Parsamagarda; a side trip to rarely-visited Bishapeer for bas-reliefs cut out of living rock and to Isfahan for beautiful mosques; then traveled on to Kabul, Afghanistan, and side trips for varied and beautiful scenery; next return to Turkey with emphasis on the Greek part, ruins of many old and historically famous places. On return to Istanbul a 15-hour curfew as the Turkish army searched for kidnappers. "A great trip highly recommended to classmates who want to be convinced that living must have been pretty good 2000 years ago if you were in the right places."

Dr. **Louis Long, Jr.,** head of the organic chemistry Laboratory, U.S. Army Natick Laboratories, Natick, Mass., was elected chairman of the American Chemical Society's Division of Carbohydrate Chemistry. . . . **Finley B. Laverty** of Los Angeles, a consulting engineer in various aspects of water supply, water pollution control and flood control, was among eight distinguished engineers selected to receive Honorary Membership in the American Society of Civil Engineers. . . . Your secretary with his wife took an early summer trip to the Canadian Rockies. This was our first experience with a conducted tour, a recommended method for us old folks who wish to avoid the troubles of planning and enjoy the comfort of no responsibilities for the entire trip. Scenery we can recommend and the pleasure of Canadian transcontinental rail travel is something to be exposed to.

We did not have too large a representation at the Homecoming weekend, but what we lacked in quantity I am sure we made up in quality. It was good to see those who were there and to have an opportunity to talk with them. . . . **Gus Hall** with a guest drove from Wisconsin and called me early Sunday morning to find out where to pick up his reservations. I saw him later at the buffet. He looks fine and after the Pops he was off the following morning to Connecticut. . . . **Sam Glaser** stopped by and joined us at our table for further talk. An illustrated article in the *Boston Globe* of July 18 describes a new M.B.T.A. station and five story garage at Quincy, Mass. It is featured as a showpiece and was designed by the Samuel Glaser Associates. . . . I met **Doc Foster** and his wife on their way to Pops where **Ken Lucas** was also in attendance. . . . Monday morning I met **Sam Spiker** just back from a European trip. . . . **Chink Drew, Jim Howard, Doc Foster,** and **Karl Van Tassell,** accompanied by his wife, were all there and we kept more or less together during the day occupying a table together at luncheon. Chink has been busy contacting various members in his search for area chairmen for the Reunion Gift Committee. He had a number of interesting letters in

reply to his requests for assistance. This is to be a large committee to spread the work and a few areas were still open.

Ed Kussmaul joined us at the reception for Dr. and Mrs. Killian. Doc Foster was an usher so we had official representation. Ed Kussmaul is still retiring by degrees. To help a friend he was functioning as consulting engineer and clerk of works for a project at Boston College. After seeing so many colored jackets worn by those attending it is hard to realize it is not so far away when we shall officially be part of the older generation, but I will say from my contacts and those that I have talked with that we do not act it when we talk about the good old days circa 1925.

I am sorry to have to report the following deaths. **Roland H. Turner,** Camp Hill, Pa., March 3, 1971 . . . Col. **Myron E. Doucette,** Setauket, N.Y., died May 2, 1971. Myron had been with the Schrader Valve Co. in various capacities for 38 years. He played a key role in the development of scientific laboratories and other educational facilities at the State University at Stony Brook, N.Y. . . . **John Hoxie,** Scarborough, N.Y., May 12, 1971. John was an authority on patent law. He also attended George Washington Law School in Washington where he received his law degree . . . **Marriott C. Johnson,** Woodmere, N.Y., July 14, 1971.—**E. Willard Gardiner,** (Will), Secretary, 53 Foster St., Cambridge, Mass. 02138

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It was a memorable event that can be reported only as highlights but the highlights start with the Inn and the weather. Don Cunningham's choice of Chatham Bars was so successful that a tentative reservation has been made for our 50th. Many cottages around the Inn provided conversation centers which was great so long as you were no where near the residence of the Kelly twins. Ruth and I were fortunate in sharing one with Kay and **Dave Shepard** who are quiet neighbors. There was no Shepard-Mancha banjo duet because Ray was confined with a virus but he telephoned from Florida to prove he was with us in spirit.

We had by far the largest turnout of wives—most for the first time. For Edna and **Argo Landau** it was their first and Edna entertained us with her prize winning color slide lecture on Morocco. Each slide was a masterpiece and it was quite a production with Smith running the projector and Bill Meehan juggling a beat-up tape recorder. Edna must have steady nerves or she would not have survived but the applause indicated that no one was aware of her inadequate technicians. . . . **Frank Schreiner** had been billed as M.C. but we had no idea of his capabilities at singing and as song leader. . . . In the dim light we could not establish whether **Chet Buckley** or **Harold Ryan** was the man with the voice because they part their hair exactly the same way. Later neither volunteered to take the credit.

Surprise of the evening was when Cantor **Morris Minsk** was presented by his manager **Bill Forrester.** The song "Doona" was sung without accompaniment but Morris sang with music. Although it had been planned at our 40th none of our photographers were prepared so we had Morris reenact on Sunday and it is now in the '26 slide record. In addition to running the tape player **Bill Meehan** ran all the sports events—golf, shuffle board, tennis etc. and reported no casualties.

Joe Levis wasn't around to assist Bill but did stop by for an hour on Saturday to greet the Class. . . . **Dick Pough** was on hand with Leitz bird glasses dangling from his neck—we would think they would be uncomfortable to sleep in but assume Dick wears them to bed. . . . **Stark Draper** was unusually quiet—the Kellys were apparently unable to lead him astray. . . . **Elton Staples** asked everyone he met to drop over to his place nearby—unfortunately we had another commitment but those who went say it was delightful.

There are enough '26 people now in the Cape area to have a meeting most anytime. In addition to Elton there's John Spence, Sam Brooks, Harry Howard and Don Chase who had just moved in. You should have seen **Sam Brooks** dance, propelled by his pacemaker or whatever makes a repaired heart tick. I couldn't have done it 20 years ago! . . . **Harry Howard** having had a recent eye operation was wearing a patch but a month after reunion I saw him on the plane to N.Y. and he was in great shape. . . . We looked at slides back to our 20th and all present ended up congratulating each other—I guess for being present. The long distance medal of course went to **Bill Edwards** from Honolulu who still spends his waking hours promoting his perpetual calendar. However, many others came a long way to reach Chatham—the Bruce Powers from Arizona, the Arther Fullers from San Diego, the Larry Cummings from Victoria, B.C. and the Frank Stricklands, via a new Volvo, from Seattle. Bob Sherwood made it from San Juan and Tony Gabrenas from Miami. We could go on but if you really would like a list of all who attended we will make one up and send it to you.

Knowing **Tom Green**'s interest in old clocks, we casually asked him some questions about a rare type called a Lyre clock. By the next day he had located one in the Pleasant Bay Antique Shop so we went over and took a look at the thousand dollar rarity. . . . The clambake was a great occasion to circulate and also to take pictures. We must have a slide of everyone who attended. Obviously the weather was still fine and it held Sunday as we left for **Mary Salmon**'s home in Hingham, which was manicured to perfection. With the Class driving from the Cape we arrived in relays to enjoy the Salmon's hospitality at their lovely home. Many went on to the Pops but we headed for Pigeon Cove in order to be fresh for Homecoming on Monday.

The outstanding event, of course, was the tribute to our classmate **James Killian** at his retirement and the reception in honor of Jim and Liz. The Class was doubly honored since Dave Shepard was selected to pay tribute for the Alumni Association and to present a book containing a bibliography of Jim's writings and speeches. This was the grand finale for our 40th but things were not over even then. Jim has since been elected Honorary Chairman of M.I.T. as of June 30. Dr. Vannevar Bush who has been Honorary Chairman since 1959, requested the change as a tribute to Jim.

With our 45th now history you had better start thinking about the red blazer you will need for our 50th and hope that we can find a chairman who will do as well by us as Don Cunningham. Cheerio until December.—**George Warren Smith,** P.O. Box 506, Pigeon Cove, Mass. 01966

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The class dinner, held at the Algonquin

After the reception honoring Dr. Killian, 1927 group pauses in front of the Algonquin Club where the class dinner was held. Left to right: Fisher, Harris, Mrs. Burley, Mrs. Hibbert, Miss Jane Burley, Mrs. Anderson, Anderson, Hibbert, Robbins, the Connells (unfortunately mostly hidden), Dike and (the now) Mrs. Arnold, Mrs. Harris, the Lyles. (Photo by J. Burley)

Club in Boston, at the time of the Homecoming on June 7, was full of surprises. Right at the top of the list, **Dike Arnold,** our president, showed up with his fiancee, the charming Mrs. Jean Wilson of Weston. Their wedding took place on June 25 in the presence of the immediate families at the Wellesley Congregational Church. Their wedding trip took them to Hawaii. We wish them much happiness.

But back to the dinner, **Betty Jackson** surprised us all by coming from New Hampshire. Glenn was certainly missed by us all. Another welcome but unexpected guest was Jane Burley, daughter of Joe and Ruth. Jane was officially the last baby born in the Class at the time of our 25th reunion; now she is a Vassar junior. . . . Dr. **Harold Edgerton** not only brought his wife, Esther, but also, at Dike's suggestion, a projector and slides. His after-dinner slide-talk on stroboscopic photography had our eyes popping. His immediate plans call for a renewed search for a city lost under the Mediterranean. There were some speeches which didn't exactly come through loud and clear. Dike was talking about how Hibbert electioneered Lyles into the job of senior class president. . . **Ezra Stevens** had a story about Sam Ward chicken. Mark Rollins revived all the words of Eddie Miller's song "Would you believe it, the tubes were cherry red—I didn't lose my head, etc." This was very popular.

My count shows 32 in attendance: Betty Jackson, Harold and Esther Edgerton, Ned and Winifred Anderson, Dike Arnold and Jean Wilson (now Mrs. Arnold), Joe, Ruth and Jane Burley, Art and Polly Connell, Bud Fisher, Dick and Mary Hawkins, Ray and Zella Hibbert, Jim and Molly Lyles, Warren and Ruth Priest, Mark Rollins, Charlie and Eleanor Smith, Ezra and Cecil Stevens, Bill and Eileen Taggart, Dick and Dorothy Piper (Dick transferred from Amherst and is partly 1928), Joe and Ann Harris. George Houston attended the lunch but had to regret the dinner. Others who were at the lunch included Mr. and Mrs. Morris Leonard, Mr. and Mrs. Ralph Peterson, Mr. and Mrs. Lauritz Rasmussen, Warren Ward.

Hopscotching the Headlines

Morgan Collins, Professor of Business Administration at the University of Michigan, retired from the active faculty in May and was concurrently appointed by the Regents as Professor Emeritus of Business Administration. He writes: "Ann Arbor and the University have so much to offer the retiree that my wife, Georgette, and I have every intention of continuing to live right where we are now. But of course holidays can be longer and more frequent." . . . Over a year ago I wrote of the exceptional book that **David Knox** was writing concerning his wife's speech disability resulting from a stroke. This book, *Portrait of Aphasia* has now been published, has received high praise from many quarters and is a textbook candidate for medical schools. In Huntington, Mich., where Dave lives and is a past mayor, June 16 was set aside as "David Knox Day." Dave autographed copies of the book at the Huntington Library and Cultural Center. Mrs. Knox had played an important role in founding this library. Dave, with true humility, writes that he hopes the book will help others struggling with the same problem.

Since retirement, **Joe Burley** has become deeply interested in an apartment project for the elderly in Milton, now in the process of construction. Joe has the key job of being in charge of the finances. To fill out his days, Joe is chairman of the Milton Citizens Concerned About Drugs, and is building and grounds chairman at his church. Then to fill in the minutes between the hours, he dashed off a lengthy letter to the Boston papers about the Massachusetts tax program and appeared at the State House for a hearing on the same subject. . . . Mary and **Dick Hawkins** have been on a cruise of the Saguenay River and on to St. Pierre and the Gaspe, returning via Montreal. He writes that it was beautiful and relaxing. . . . Mystic is on the route travelled by **Ray Hibbert** on his manufacturers' representative rounds. We took him to task for coming by our house and just looking. Last week he came by again and knocked. To our regret, we were out, but don't let that discourage any other prospective callers.

Ed Damon has written a postcard from Narvik, Norway, near the Arctic Circle with continuous sunshine in the summer. Ed has planted the flag just about everywhere since his retirement. . . . Governor Nelson Rockefeller has appointed **Wesley Meytrott** as chairman of the Council for the Downstate Medical Center (State University of New York) in Brooklyn. Wes has been active in hospital affairs for many years and currently heads up a cooperative organization of six Brooklyn hospitals. He has retired from Consolidated Edison of New York. . . . After retirement last year, **Charles Pope** has spent more than a year in Europe and now is heading for the west coast for six months. . . . **Bill Tucker** moved from New Jersey to Rancho Bernardo, Calif. His note says that he is playing golf, bowling, heading up the Lapidary Society and having fun. . . . **Brad Stetson** at Punta Gorda, Fla., is still high on the "Sunshine State." . . . The golf course also claims a lot of **Dwight Moore**'s time since he sold his business last year. He reports two marriages but is now single. . . . With a serious heart ailment, **Nelson Clark** has settled in the "center of the least polluted area of the Ozarks"—Harrison, Ark. He would very much like to have a card from any of his old associates.

Deceased

We regret to advise of the death of **Reginald F. Jacobs** on May 5. His home was at 53 Leicester Rd., Belmont. He had lived in this community for 21 years. Born in Boston, he came to Tech from Mechanics Arts High School and earned his S.B. in Course I. After Tech, he received a B.L. degree from Northeastern University. The *Belmont Citizen* wrote of Reggie: "He worked for the Department of Public Works of the Commonwealth of Massachusetts for over 42 years and was working on bridge engineering at the time of his death. He served over 35 years in the U.S. Army Reserve Corps of Engineers, including service in Europe during World War II as commanding officer of the 183rd Engineers Combat Battalion. He retired as a full colonel in 1963."

We record with regret the death of **George J. Saliba** on July 6. His home was at 170 Hillside Ave., Englewood, N.J. George was always active in M.I.T. and class affairs (and will be remembered for the beautiful steins he produced for our 25th reunion). He came to Tech from Northeastern University and graduated in electrical engineering. His business career started at Brooklyn Edison, concentrating on sound recording. Only five years after graduation, he founded and

George J. Saliba, Class of 1927

became president of Presto Recording Corp. of Paramus, N.J., which is now a subsidiary of the Siegler Corporation. The company manufactures disc and tape sound recorders. George was a licensed professional engineer in both New York and New Jersey. In 1966, retired, he wrote that he was president of the Knickerbocker Country Club at Tenafly—"no salary, lots of work." The *New York Times* referred to his being the author of *Home Recording,* a textbook in his field.

Peripateticity

The Bob Wallaces have found themselves a small town house in St. Charles, Ill. at 1100 Geneva Rd.; Paul Harrington has moved from Bethlehem, Pa. to Mountainside, N.J.; Mrs. Frederick Hunt (the former Katharine Buckingham) from Belmont and Harvard to La Jolla, Calif.; Professor Allan Gifford has a new address at 69 Amble Rd., Chelmsford; Dr. Harold Haase has moved in Milwaukee to 2253-A So. Layton Blvd.; Col. Amos Ackerman now lives in Orlando, Fla.; Dean Samuel Hershey's address in Rockport, Maine is 8 Pleasant St.; something has caused Col. Paul Ivancich—a longtime resident of San Angelo, Texas—to post an address at 410 A St. S.E., Washington, D.C.; the computer is flashing all kinds of lights to show that Edward Jones has moved to 10728 Sarasota Circle, Rancho Bernardo, San Diego, Calif. Rancho Bernardo is where Bill Tucker lives, too. (See above). Just to wind things up, there are some people who don't move, like Dan Sullivan who has lived more than 20 years at 529 East 235th St., Bronx, N.Y.—**Joseph S. Harris,** Secretary, Box 654 Masons Island, Mystic, Conn. 06355

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Our class is always well represented at the annual M.I.T. Homecoming Weekend events in June. This year was no exception. Including the girls, there were 21 on hand to enjoy an outstanding program. Those attending were: Ruth and Chris Case, Fran and Jim Donovan, Ruth and Arthur Hall, Martha and Wallace Heidtman, Florence Jope, Mary Nichols, Gladys and Dave Olken, Dorothy and Herb Swartz, Walter Smith, Dodie and Ed Walton, Lucille and Sam Weibel, Ruth and Abe Woolf. **Ed Walton** wrote afterward to say how much he and Dodie enjoyed it all. Quoting Ed: "We had a good time and the seminars were enlightening. Actually, we enjoyed more the time three years ago at which various departments outlined major research projects. I guess that was because we felt like students again—and that takes a lot of doing!"

Don Fraser thoughtfully wrote to tell us: "I've followed with interest the Class Notes in the *Review* and how one after another of our classmates is retiring from the old routine and starting off on new endeavors, interests or just relaxing. Well, please add me to the retired list. Gulf Oil liberalized their retirement plan last year, so after 40 years with the company I took early retirement (a year early) this spring. It's time for fun and games while Martha and I have our health. I have no plans at present to do anything but take it easy and help Martha with her orchid growing." At the time of this letter the Frasers were about to move to Florida and gave their new address: 538 Key Royale Dr., Holmes Beach, Fla. 33510.

A benefit dance concert was presented by the Cambridge Martin Luther King Memorial Fund Trustees at Kresge Auditorium on June 1, 1971. The program was given by Gus Solomons, Jr. and Company. Gus, Jr. '61, the son of our own **Gus Solomons,** is well recognized for his dance work and choreography. Jim Donovan attended the event and reported it as excellent. The elder Solomons were there and met with Jim. We have had post cards from Nat and **Des Shipley** while they were traveling in Greece. Des tried to get in touch with John Houpis but was unable to make any contact. The Shipleys say the country is wonderful, the climate great and prices reasonable. A news item in the April 21 issue of the *Rappahannock Record,* Kilmarnock, Va. tells us that "Captain **Frederick D. Riley, Jr.,** United States Navy (Retired) has been appointed aide-de-camp on the staff of the governor of Virginia effective April 1." Fred retired nine years ago, moved to Kilmarnock, and took up teaching at Christchurch School where he has been head of the mathematics department.

In June **Arch Archibald**'s wife, Clara, was in Cambridge for a Radcliffe reunion. During the reunion the Radcliffe College Alumni Association gave Frannie Donovan a citation in recognition of her outstanding accomplishment in distinguished services to the school. Clara was at the luncheon and later sent Frannie flowers in congratulation. . . . A news release of the American Society of Civil Engineers dated May 7, 1971 lists eight distinguished engineers who were selected to receive honorary membership in the society. Included was **George Palo.** George, who retired as Manager of Engineering Design and Construction for the Tennessee Valley Authority now practices privately as a consultant. This honor elevates George to the highest level of Society membership and is awarded in recognition of "acknowledged eminence in some branch of engineering or in the arts and sciences relating thereto, including the fields of engineering education and construction."

In a note from **Charlie Worthen** we have learned that **Herman Krantz**'s wife died on July 1. Herman's address is: Stigler-Otis S.p.A., Via Maure Macchi, 28, 20124 —Milano, Italy.

Several news panels have been received from the Alumni Fund Office and we are pleased to relay their messages to you. **Elwood Anderson** says: "Retired February 1 from Ethyl Corp. after 42 years." . . . **Vernon Brown** reports that he retired from Tennessee Valley Authority after 34 years of service. . . . From **Don Buckner** we have: "I retired December 31, 1970 after 42 years in the field of public health. I was an administrator, then for ten years past, the Director of Public Health Education for the Department of Health, Suffolk County (Long Island), New York. I am enjoying my retirement." . . . **Bruce Hart** writes: "I graduated in Course II and married one hour later. I am still married to the same girl. She was Doris Weston of Windsor, Vermont. Her brother, Barrett Weston '29, Course VI, introduced us. I worked 28 years for Curtiss-Wright and retired in 1956. I have lived on the Hackensack River for 55 years." **Dick Goble** reports: "I retired March 1, 1970 to this delightful area, built a new home and now have it landscaped. Am enjoying golf, boating, fishing, and yard work."

From **Art Smith** we learn: "I retired December 31, 1970 as vice-president, sales, from Auto Stamping Division, Sheller Globe Corp. in Toledo, Ohio, where we plan to remain. Took some vacation in the Bahamas and Florida

during the winter. Now playing golf more than anything else. Plan to take on some social responsibilities this fall." From **Wentworth Taber:** "I retired the end of 1968 after working 34 years with Simplex Wire and Cable Company in Cambridge. Now I spend time around my Reading, Mass. home and New Hampshire summer property and in traveling around the country. This summer I expect to drive out to the Canadian Rockies." . . . **Jim Donovan** has had several letters from **Bill Hurst** who has just finished writing a paper that was three years in the making. Bill believes that he has really accomplished something. He says: "A lot of water has gone over the dam since I sat in duPont court in 1924 wondering where tuition was going to come from." Bill was in Boston recently on business and to visit his brothers. He invited Jim and your secretary to lunch at Locke-Ober's. We had fun reminiscing about Course X but considerably less fun discussing the Institute's recent problems.

We regret to report at this time the deaths of two classmates. **David B. Wood** died on January 10, 1971 following a heart attack. Dave went to work for Alcoa after graduation and progressed with his company through many years. He retired early when his division moved away from Cleveland. He then acquired an M.S. in education and taught physics and mathematics in Cleveland high schools until the time of his death. Besides his wife, Mildred, Dave left two sons and two daughters. **Benjamin F. Miller,** M.D. died on June 28, 1971. While still a senior in Course X-B, Ben became interested in medicine. Following graduation he entered Harvard Medical School where he received his medical degree. For many years Ben's activities centered in Boston where he served on the staff of the Peter Bent Brigham Hospital. More recently he had been engaged in medical research and was Associate Professor of Medicine at Harrison Department of Surgical Research at the University of Pennsylvania. He was prominent in many aspects of his profession and a busy writer for the general public. His book *The Complete Medical Guide* was widely promoted by the Book of the Month Club. Besides his wife, Ben leaves a son and two daughters.—**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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Our class was well represented in the 1971 Alumni Homecoming. The following were present: William Baumrucker and wife Doris, William Bowie and wife Sally, Karnig Dinjian and wife Helen, Paul Donahue and wife Fran, Edward Farmer and wife Helen Clare, Wally Gale and wife Joan, Paul Keyser, Thomas McCue, Virgil McDaniel and his wife, Frank Mead and wife Mary and Secretary Louise McLaughlin, Herman Meissner and wife Dorothy, Leonard Peskin and wife Martha, John Rich and wife Aline, Joseph Speyer and his wife, Elizabeth Stefani, David Wilson and his wife, and John Wilson and wife "D.A."

We had a delightful international buffet on Sunday afternoon followed by the

E. H. Perkins, '29

Pops with an interesting program. At the luncheon on Class Day, **Paul Keyser** opened the meeting with an invitation to the only surviving members of the Class of 1895 and 1905, who were present to join him at his home, wherever it may be, on December 31, 1999 and have a champagne toast for the occasion. He said that having made it this far, they might be on hand to greet the 21st century. As for himself, he said the way he felt, he might make it too. I am sure it was an oversight on the part of Paul not to have extended the same invitation to those Twenty-Niners who also might make it.

Francis M. Mead, Course VI of Belmont, president of our class, recently retired from the New England Telephone and Telegraph Co. after 36 years of service. For the past ten years, Frank has been vice-president in charge of marketing operations. Prior to his current assignment, he was general sales manager —special accounts, handling U.S. Government, power company, railroad and airline accounts. He was a major in the Army signal corps during the Korean conflict. He is the recipient of the Legion of Merit award also. . . . **Elizabeth M. Stefani,** Course IV, of Provincetown, Mass. writes "After graduation date of 1929, for a female Course IV graduate, I floundered working in Provincetown, going to Art School in Boston and Paris—married and brought up four children, three sons and one daughter."

John D. McCaskey, Course XV, of St. Joseph, Missouri, who has been attending the University of Missouri sends a brief note saying, "Have completed 60 per cent of my M.A. degree in History. Cumulative G.P.A. is 3.83 which is a lot better than I achieved in Cambridge." . . . **Richard S. Roberts,** Course X-A, of Wilmington, Del., writes "Retired in December 1968 after 38 years with Dupont, mostly in the engineering department. Since retirement, we have indulged in travel, a South Pacific cruise in 1969, a nine month trip to Africa and Europe in 1970-71. After 11,000 miles of driving in Europe, we are staying within the United States and Canada."

Lester H. Fox, Course VI, of Towson, Md., says in his note "am retiring and will be going back to Starkville, Miss., the locale of my teaching (Mississippi State University) after graduation from M.I.T." . . . **Edwin H. Perkins,** Course VI-A of Ipswich, Mass. writes, "I retired on June 1, 1971 from Bell Telephone Laboratories after 41 years of service. I live at 13 Bowdoin St., Ipswich, Mass." . . . **Walter H. Winchell,** Course VI, Garden City, N.Y. says "my son Walter is studying for his Ph.D. at Syracuse University, my daughter Dorothy, has just graduated from Skidmore College and is employed. (So you can see I can't give very much to the M.I.T. Fund.)" . . . **Vahram G. Miskjian.** Course VI, College Park, Md. expresses his dissatisfaction for the Nixon Administration which is responsible, he believes, for his unemployment.—**Karnig S. Dinjian,** Secretary, 32 Oldham Rd., Arlington, Mass. 02174

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By the time you read these notes the summer vacation period will be over, and I hope you all had a pleasant summer. As usual, a respectable number of items has accumulated during this period. . . . **Joe Becher** is chief electrical engineer of Burns and Roe, Inc. in Oradel, N. J. The Bechers' son, Joseph, 3rd, graduated as an electrical engineer from Worcester Polytechnic Institute but apparently has elected the bucolic life since he is operating a farm in Maine. . . . **Mark Culbreath** reminds me that shortly after his retirement from Burns and McDonnell Engineering Company at the beginning of 1969, a resume of his career appeared in the notes. Since then he has done a few consulting jobs, but mostly has been enjoying his retirement. He has continued his work at St. John's Methodist Church (Kansas City) as a member of the official board and president of the adult Sunday school class. . . . **Henrietta Johnson Dane** helped plan the 40th Reunion as a member of the Reunion Committee, but unfortunately at the last minute was unable to attend. She and her husband Ernest have three children: Thomas, who graduated from Boston University and Harvard Business School; Helen, who graduated from Pine Manor Junior College; and Charles, who after a year at Boston University is in the U.S. Marine Corps. The Danes have a total of 15 grandchildren. Henrietta is a trustee of Pine Manor and secretary of the Board of Governors of the Skating Club of Boston.

Joe Devorss has retired from the U.S. Rubber Company's Washington, D. C. office and is living in Falls Church, Va. His son James obtained an M.D. at George Washington University and now has a fellowship in cardiology at the University of Vermont. Daughter Joanne is in high school. . . . **Al Deyarmond** retired as of March 1 from the General Electric Company Center for Advanced Studies (TEMPO) in Santa Barbara. He has continued to do a little consulting work and has also continued as elder and clerk of session at the El Montecito Presbyterian Church, but is mostly enjoying retirement. The Deyarmonds have two children: Susan, who is married and has two children; and Bruce, who is unmarried. . . . **William E. "Cul" Cullinan** retired from the Federal Aviation Administration in 1970 as Area Manager for New England and New York after 34 years in airport development work, no-

tably Dulles International in Washington. He is now manager of Logan International in Boston. He is also associated with Engineering Consultants on airport work and is a director of the Aero Club of New England. The Cullinans have three children: Carol, who is married and has five children; Gordon, who builds racing cars and is an automotive shop foreman and Air Force jet mechanic; and Stephen who is with an architectural and engineering firm. . . . **Norman Dolloff** retired several years ago as Chairman of the Geology Department at San Jose State College but has continued to teach geology there. He is writing a textbook which he expects to publish in about a year and is also a member of the Santa Clara County Committee on School District Organization. The Dolloffs have a son David in West Valley Junior College.

Bill Dickerman retired officially about nine years ago but has continued to do part time consulting work in the chemical engineering field, generally in the field of petroleum refining and particularly catalytic cracking. Bill and his wife make occasional trips to Europe and spend their summers at Siasconet on Nantucket Island where they "sail about in our ageing Boston whaler." . . . Those of you who attended the 40th Reunion will recall that the **Fred Dickermans** arrived in a camper. Fred says that they drove it 8500 miles last summer through New England and the maritime provinces of Canada before returning to their home in Pinellas Park, Fla. Last fall they sold the camper and spent the winter building a mini-motor home out of a Dodge Maxivan in which they plan to drive to the 45th Reunion. The Fred Dickermans have three children. Kenneth went to M.I.T., the University of Seven Seas, and Georgia Tech where he obtained a B.S. in architecture. He is currently in the Air Force at Craig A.F.B. in Selma, Ala. Daughter Judith is married and son Alfred is a pre-medical student at University of Miami in Coral Gables.

Another participant in the 40th Reunion was **Louise Dingwell** from whom we have received a chatty note. Louise is a real estate broker in both Rhode Island and the neighboring portions of Massachusetts with an office in Seekonk, Mass. In addition, she has many outside interests. During the course of a recent European trip she visited all of the "Care" stations in Italy and Greece. "Previews-Foreign Real Estate" interests her very much, especially the old castles in Scotland and Ireland. She is active in the Mayflower Society and the D.A.R., of which she is National Defense Chairman of a local chapter. Louise says she attends most of the meetings of A.M.I.T.A. in Boston and that they were very ad-lib this year, perhaps due to the fact that so few women M.I.T. graduates have achieved faculty positions equivalent to those of their male counterparts. She believes that A.M.I.T.A.'s activities in this respect have influenced the thinking of the younger undergraduates on neighboring campuses. Louise is looking forward to attending the 45th Reunion. . . . Warren Henderson of the Class of '33 was kind enough to send me a list of our classmates who attended the annual fiesta of the M.I.T. Club of Mexico City which takes place in March each year. It appears that **Emilio** "Maco" **MacKinney. John Moriaty** and **William Reeder** all attended with their wives.

Changes of address: Hermann S. D. Botzow, 132 State Rd., Hinckley, Ohio 44233; Charl D. Cillie, Goose Pond, Springvale, Maine 04083; Wayne S. Hertzka, 25 Main St., San Francisco, Calif. 94105; Susan M. Tully, Main St., Fryeburg, Maine 04037; Elroy Webber, Frum Rd., Athens, Ohio 45701; Ralph H. Swingle, 6870 Oregon Ave. N.W., Washington, D. C. 20015—**Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y. 10036

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Although I was unable to attend our 40th Reunion for business reasons, I understand it was a great success and attended by over 110 classmates and their wives. **John Minami** and I celebrated it together in Tokyo and had a great time visiting a number of nightclubs. During the same trip, I visited Bangkok and Australia and spent a most pleasant three days in the Fiji Islands on the way home.

Dave Buchanan, who was at the reunion, has recently been promoted to Assistant to the Vice President at Consolidated Edison Co. of New York. Congratulations, Dave. . . . A recent letter from **John Chibas** says, "I am writing to inform you that I retired September 1, 1970. From 1936 to 1967 I worked in Havana for Compania Cubana de Electricidad (American and foreign power), where I became head of the Engineering Department, until nationalized. I am very anxious to hear from my old classmates and inmates of the M.I.T. dorms (shades of Runkle!) and also from former members of the M.I.T. Club of Cuba. I promise to answer all letters when and if they reach my hands. I am in good health and spend most of the time reading and walking, which are my favorite hobbies nowadays."

Art Fuller also writes, "I am indebted to someone for the brochure about the members of our class, and wish to thank you or those responsible. I couldn't make the reunion due to my wife's heart attack which took place on April 25 and left her just a bit too weak to venture to New Hampshire. She has now made a nice recovery so we will travel to our own place at Ossipee, New Hampshire soon. Another reason for writing—note that you do not have an address for my old buddy of Course XI, **George Chapman.** We have swapped Christmas cards for years (don't recall getting one last year, however) and as far as I know he still lives with his wife Joan at 1075 Sawmill Gulch, Pebble Beach, Calif. The last letter I received indicated he was fine and would like me to visit with him. So, unless there has been a recent change, I think he is there. I trust the reunion was a success. Don't think I could make Mexico City but certainly would look forward to the next one in New Hampshire. I am looking forward to retirement soon but things are humming with my business now and I can't let go easily."

A note from **Frank Weeks** says that after commuting for 29 years to and from Chicago, he decided to "slow up" but now seems to be busier than ever. Frank has a collection of travel slides in color, known as the "Winnisimet Collection" which he presents to various groups. His address is: P.O. Box 112, Highland Park, Ill. 60035. . . . **Henry Hartwell** told us that he has completed 35 years with G.T.E. Sylvania in jobs ranging from Engineering Test Supervisor, Area Quality Control Supervisor, Product Engineering Supervisor and Plant Manager. At the present time he is currently active in materials assurance with his suppliers but expects to retire in the not too distant future. Henry has lived in Wilmington, Mass. for the past 16 years. His son is completing his doctorate at Columbia, one daughter, Janice, is teaching in the Art Department of Florida State University and another daughter, Rebecca, is married and living in Duxbury, Mass. Henry says he is open to any good suggestions concerning retirement.

Don Holden reports that he retired from his previous employment at Newport News Shipbuilding and Dry Dock Co. in Newport News and is currently serving as Executive Director of the Council of Independent Colleges in Virginia. . . . **Otto Kohler** has retired as Business Manager of Mount Holyoke College in June 1968 and is now associated with Tighe and Bond, Consulting Engineers in Holyoke, Mass. . . . **Henry Randall** reports that since he retired he has done considerable traveling to South America, Europe and Mexico and the U.S. In addition, he has taken a trip to Florida through the Intra Coastal Waterway in his 30 foot boat, now in the Chesapeake Bay. . . . **Henri Turner** writes that he is approaching retirement. During the past four years, he has produced seven volumes of Standard Operating Procedures for the Massachusetts Department of Public Works and the eighth will be finished shortly. This is the first time that these operating procedures have been put down in black and white.

New addresses reported since the last Class Notes are as follows: Col. Howard A. Bogert, c/o Robert C. Bogert, 5439 Round Meadows Rd., Hidden Hills, Calif.; John E. Chibas, Calle G No. 573-Depto 46, Havana 4 Cuba; Mrs. Ruth P. Fuller, 633 Harvard St., Vestal, N.Y.; Donald L. Herbert, Route 2, Mountain Home, Ariz.; Samuel A. Janney, Box 388, Gloucester, Va.; Abe I. May, 6826 S. Bennett Ave., Chicago, Ill.; Arsene W. Morin, 8911 Northeastern Blvd., N.E., Albuquerque, N.M.

With sadness I report the death of **Leonard Johnston** on May 7, 1971. **Dave Motter** died after suffering a stroke in the car on the way home from a vacation in Florida. **Lawrence Mohr** passed away on March 1, 1969. Our deepest sympathy to their families.—**Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880

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Gaynor Langsdorf, serving as chairman of a new Regional Advisory Board for

Alumni Affairs, organized a very successful visit in June by President-Elect Dr. Jerome Wiesner to the M.I.T. Club of Northern California. It was the first time leaders of the Education Council, Alumni Fund Council, Visiting Committee members, officers of the M.I.T. Club and members of the Regional Advisory Board were all brought together using the new "Big Tent" idea.

President Howard Johnson paid tribute at the faculty meeting in May to Professor **John T. Nickerson,** Professor of Nutrition and Food Science who will retire at the end of this academic year. Mr. Johnson said "Professor Nickerson is one of the pioneers in investigating the possiblities of food irradiation as a means of preservation". John is a native of Nova Scotia, studied at M.I.T. receiving the S.B. in 1932, S.M. in 1934 and Ph.D. in 1938 in food technology. After working several years in the food industry, he returned to M.I.T. as a research associate and was appointed assistant professor in 1950. . . . **Charles M. Thayer** of 402 Ridge Ave., Kennett Square, Pa. has been appointed manager of the DuPont Company real estate division. Charles joined DuPont in 1941 and has been in the real estate division since 1945 and became assistant manager in 1956. He is also chairman of the Kennett Square Zoning Board. . . . Dr. **Joseph M. Stowell** is active in the practice of general surgery. He is planning a two month trip with his family to Scotland and southern Ireland. His second daughter, Sally, was recently married. . . . **Francis T. Gowen** retired from the Raytheon Company in April this year and is dividing his time between Wellfleet on Cape Cod and Newton, Mass. The last of his four children graduated from college this year. . . . **Thomas H. Jenkins** has accepted a Federal appointment as director of the National Gas Survey for the Federal Power Commission. He has moved from San Francisco to Washington, D.C. . . . **Robert B. Semple** has been elected chairman of the board of the B.A.S.F. Wyandotte Corporation. Bob has been the company's president since early in the year when the Wyandotte Chemicals Corp. and B.A.S.F. Corp. were merged. . . . **Howard A. Kinzer,** 61, 1540 Dahlia Ct., McLean, Va., and a native of Manhattan, Kansas, died June 5, 1971. He was retired as chief right-of-way engineer for the West Virginia State Highway Department and at the time of his death was a part-time tax consultant with H and R Block, Inc. Howard attended George Washington University and received S.B. and S.M. degrees in civil engineering from M.I.T. He was a member of Phi Sigma Kappa fraternity and his fraternity brothers John Best, '35 and George Bull, '34 were able to attend the service.

Captain **F. Carlyle Roberts, Jr.** retired in October 1970 from the U.S. Public Health Service after 28 years of service. . . . **Richard B. Park** joined Travelers in March 1971 to work in the venture capital area in their securities department. He says it's very exciting after all those years of engineering.—**Elwood W. Schafer,** M.I.T. Rm. 13-2145; **James Harper,** Assistant Secretary, 2700 So. Grant St., Arlington, Va.

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Here we go again on a brand new year. An old New Hampshire saw says that if you wish to teach the dog something, you must know more than the dog does. I confess that I didn't, when I told you fellas and gals that the *Review* staff told us that we had to cut down on Class News as an economy measure. For your future guidance, this does not mean that you folks are to cut down on material sent to me. Please resume your very fine habit of sending it all in, and allow us to do the editing. We are allowed, generally, a full page in the *Review,* and in the June issue I did not have enough for even that much space. This is deplorable. If I get too much stuff, I can assure you that everyone will get a mention, however short, as our news is best when many, many classmates find their names, and short stories in our exclusive column. It is exclusive, as no one but us appears in our bit. Please fellas, be kind to me and all the other classmates.

First on the agenda is our part in the Homecoming festivities. About the usual number made their appearance, to wit: Vice Presidents **Ellis Littman,** and Roz, **Clarence Westaway, Dayton Clewell,** and then, and best of all, **Jim Turner.** our esteemed President, and his Edna. Then the usual number of the faithful: **Art Hayden** and Ruth, **John Maxim** and Hazel, **Ed Rowell** and his gal, whose name has eluded me. Though I didn't see them I am informed that **Lincoln Ryder** and Mrs. Ryder were also in attendance. Apparently all but Dayton Clewell attended the very successful Pops Party at Symphony Hall. Dayt Clewell appeared Monday, rather late but had an important duty; he was usher at the reception for Dr. James Killian, retiring Chairman of the Corporation. He and Jean will be on Diamond Island in Lake Winnipesaukee around the last of July, and, praise be, he will look us up. Son, Don, and his wife will join them for part of the vacation. Don is now Assistant Professor at the University of Michigan Medical School and the Clewells are rightly proud. Well, we are rightly proud of the Clewells, too.

Not much from Westy, as usual. He says he is now playing the field, with no particular girl, which is not so newsy. I interpret to say that he is hard at work as Chairman of the 40th Reunion festivities at Chatham Bars Inn. . . . Ellis Littmann and Roz stayed at the Ritz-Carlton, as Leona and I did; we sat with them at the Pops and saw a lot of them otherwise. Ellis is digging in real deep in his job as 40th Reunion Gift Chairman and hence is not really incommunicado, but somewhat one track-minded. The rest of his committee is still waiting for instructions, I am reminded to say.

Jim Turner, neither last nor least, and his lovely Edna were with us all at the International Buffet and at the Pops, but Jim had to dust out of town late Sunday evening, thus missing the Monday program and Jim Killian's retirement reception. Couldn't get much out of Jim and Edna, except scattered bits of everyday living, including Edna's golf game. It is always a joy to meet and visit with these really top folks. . . . Now comes **Art Hayden,** and I find I know less about him than I did 40 years ago. Whadda clam, but as always, my boy.

Ed Rowell and wife attended the Pops, but were with a party of eight, so they had to sit in the balcony. He looked me up, however, and came through with some news. Ed, Jr., has just graduated from Boston University Law School, and the Rowells are real proud of that boy. Their son Clark has received a Master of Science degree from M.I.T. (Sloan School of Management.) Which reminds me, whatever happened to our irrepressible **Dick Morse** and the steam car? The answer—in part—is elsewhere in this issue of the *Review.*

Greatest surprise of all was one of our own **Eddie Miller** boys, **John Maxim.** John

has apparently done well, even though I remember nothing except that John found out that he could do better without us and left the Institute without bothering with the old degree. I actually had to ask the guy who the heck he was. John is Chief Estimator for Stone and Webster, in Boston, I expect. John and Hazel have three boys: John, Jr., is a Yale man and a lawyer, Peter is also a Yale man, an M.D., and David, according to John's written story, either did not go to college or John forgot to say where. It appears that the Maxims are loyal church workers. Sure glad to see him again, after 40 years.

Note to **Steve Crick;** Wendell Bearce, '32, sat with us at the reception, with his good wife, mentioning you as an opener for discussion. Did not Wendell have a brother in our class? I can't find his name any place. I will chide Steve (and **Al Moeller)** briefly, and not too often, in the hope of hearing from you. Imagine a guy with his own plane, and me with a landing field, and he never drops down on us, or writes us.

We hear from still another vice president, **Bill Harper,** doctor deluxe, in chiropractic, in Texas. I have had to tell Bill that policy is my dictator. I can quote him, but not at length. Bewailing what he reads about undergraduates and new graduates, Bill says, "We were depression babies in 1933, but most M.I.T. men of that period have reached, or nearly so, the top of their professions, and none of us got very much coddling along the way." What you say, Bill, is 100 per cent true, but space forbids any discussion. I do believe that there is just as large a percentage of good men in classes graduating today as there was way back when. Our trouble seems to have been that we did not know that we could dissent. We didn't have any rabble-rousers who could fan our dissent into the violent flame, which seems to have spread and now subsided, or so we hope. Fellas and gals, this Harper is one of our most faithful and loyal classmates, and like a lot of Texans might be considered a bit odd, but, ain't we all in many respects? Thanks a million, Bill, and you just write me any dang thing you wish, just so long as you write. I, and Kathy Sayre will do the editing.

Still another vice president, **Beau Whitton,** drops me a card at the drop of the well-known sombrero. Beau and Daphne returned in June from an extensive trip to the Canadian Rockies. They toured from Spokane to the Yellowstone, British Columbia, Lake Louise, Glacier National Park, etc., not necessarily in that order. Beau, how right you are. I have seen most of all that, some of it many times. I once spent 10 days in southwest Montana, on an angus inspection trip, attended by over 300 angus men from 31 states. The cattle were really in the mountains. We visited many ranches, no one of them under 9,500 feet. They stay there not only in the summer but all year. In 1946 Leona and I took a transcontinental train trip from Toronto to Vancouver in the winter, we can never forget it—most spectacular, with an added feature: ten hours in a snowshed (look it up). Many thanks Beau, and no bragging about your first granddaughter! One can claim little credit for such—only pleasure.

Last of the personals, but far from the least, is a couple of pages, from vice president **Calvin Mohr,** who is president of the Chicago chapter of the Filtration Society. He read a paper at the joint meeting in Cincinnati, of the Filtration Society and the American Institute of Chemical Engineers, "PX Polypropylene, a New Material of Construction for Plate and Frame Filter presses." Whadda title! Cal phoned **Art Mason** from the Pittsburgh airport, and Art says that he still sells insurance but is handicapped by severe arthritis, which leaves no room for much pleasure. His son and daughter are through school and are living with him. He has, for obvious reasons, seen no Pittsburgh classmates. Cal visited du Pont at Niagara Falls, earlier, and met and visited with **Frank Twomey,** who is an engineer working on the project for which Cal's firm will furnish filters. Frank's daughter is married, and his son is in college. He also has a younger daughter in high school. Frank has his 35-year pin from du Pont. Cal unfortunately had no luck with his phone calls to classmates in Cincinnati. He says that they either have all moved or have unlisted phones. Tell me who they are, Cal, and I will tell you where most of them are. Cal is still trying to track down **Chuck Thumm,** as is also **Harry Summer.** Chuck has said that he doesn't like us, but I can't find out specifically why. Howcum I don't hear from Harry Summer? Doan he like me any more?

We have a clip from the Manchester, N.H., paper on our **Stanley Walters** of Sullivan, N.H. Stan is, or was, running for school committee in his home town, and is the perennial Town Moderator. Now why didn't Stan tell me at the April Alumni Council meeting? No, I get it from the papers. . . . Now another of our irrepressibles: **Don Fink.** He too, allows the press to notify me of his activities. It seems that Don is now serving on an advisory committee, appointed by President Nixon, to explore sources of health care facilities from many federally sponsored projects and of personnel, who can contribute to the general health care effort. Don has worked his way to Vice President in charge of all research for Philco since 1959. How the heck did I miss that?

Again we are saddened to hear of the passing of a few of our classmates. Undated is a clip telling us of the passing of **Chester Dodge,** who received a master's at M.I.T. in 1933, after graduating from Wisconsin. Chester lived in Waban and had been active in engineering all his life. Many electricals will remember him, though he spent rather a short time with us. Another member of our class, has passed to his reward: **John W. Campbell,** Editor, of *Analog,* a science fiction and fact magazine. John was with us only a short time, taking his degree at Duke. He spent most of his entire life in his kind of writing, and was with *Analog* for 34 years, being the editor since 1937. Nearer home, to me at least, is the passing of **George Newman,** a civil while we were at school. George did not wait to graduate with us, as he was probably in too much of a hurry to get to work. George was the Suffield, Conn., forecaster for the New England Power Exchange at the time of his passing in February of this year. George also attended Boston University. We knew George very well indeed and remember him well, and with fondness. To the survivors of these three, we extend the heartfelt sympathy of our class. As time goes on, we find too many leaving us, but it is the will of our Lord.

The Alumni Fund capsule really came through at a time when we needed the messages. We have so many of these short stories as to cause us to hold over a few for a future rainy day (year end). We have space for a few: **Olavi Viita,** says his son was graduated from Harvard, 1970, is now a Rhodes Scholar at Ox-

W. Wise, Jr., '34

G. Fowles, '34

H. Mertens, '34

R. Ewert, '37

J. Engel, '37

ford. Daughter Mimi is a senior at Smith, in art history. The Viitas are building a new home at Seabury on Cape Cod.

That's it. See y'all in December. Address still Fort Rock Farm until mid-November. Leona and I send our very best.—**Warren Henderson,** Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

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As this is written, Labor Day is about three weeks away and then most of those "awful summer people" will disappear. However, summer crowds are the price you have to pay if you pick a summer resort area to enjoy in year-round retirement. After all, they're what keeps the place going the rest of the year. But they have filled up the roads this summer.

From a personal standpoint, my biggest news is that **Ray Jewett** and his wife Olga have retired here and they are living about four miles away from us. In June they moved into a house they built on land they bought just after our last reunion on Martha's Vineyard. Ray and I can yarn all we want about Tech without flak from our wives as they were a year apart in Simmons and spend as much time reminiscing themselves.

A fair bit of news has accumulated about class members over the summer. Actually going back to the first of the year is **John Hrones'** appointment as Provost of Case Institute of Technology. In this position he is the Institute's chief academic officer. Mergers, it seems, are not restricted to the business world and John's new position comes from the federation of Case and Western Reserve to form Case Western Reserve University. . . . **Walter Wise** continues his activities with the American Supply and Machinery Manufacturers' Association. He is now second vice president of the group, after serving as a director for several years. Of course, the rent money still comes from his presidency of the Henry G. Thompson Co. in New Haven. . . . **George** "Benny" **Fowles** was elected a director-at-large of the Society of the Plastics Industry, Inc. in May. He has been vice president-marketing, plastics of B.F. Goodrich Chemical Co. since 1964. Prior to this he was sales manager of plastics for 19 years. George and his wife Beth were some of my "awful summer people" this year and got to see the Jewetts in their new home. Unfortunately, I missed them—it may have been when we were off visiting our old haunts on Long Island.

It was during this trip that we spent several days with Mora and **Eric Isbister** at their summer home in eastern Long Island. He is now director of marketing for new products for Sperry Piedmont in Charlottesville, Va. We had timed our visit to coincide with the Sperry vacation so that we could see as much of the family as possible. Unfortunately, the boys were not around—they're spending the summer working for **Adrian Ross'** company in the field. . . . An item that gives me much pleasure to write about is the promotion in May of **Henry Mertens** to be executive vice president of the Central Maine Power Co. Hank and I were friends in the dorms and stewed over many problems together. The electricals will remember that the straight Course VI then was heavily directed towards utility work and Hank is the only man I knew in the course who went (or was able to find a job?) directly in the field. He has been with C.M.P. for over 36 years and had been a vice president since 1964. He was elected to the C.M.P. Board of Directors in March and also serves as a director of several other companies. . . . **Philip B. Walker, Jr.** has been elected president of the Frank L. Adams Co. in Worcester. He has been with the firm since 1946, first as superintendent, and then as vice president.

I have a number of brief comments that people were good enough to include with their Alumni Fund contributions. From Long Island, **Fran Doyle** writes "I am still on the Lunar Module (L.M.) program at Grumman, keeping L.M.-10 reliable for the Apollo 15 shot on July 25. The astronauts will drive the Lunar Rover around on the moon. It should be a good TV coverage. Regards." As we all know by now, the coverage was phenomenal (I got better pictures from the moon than I do from Channel 2, the ETV station in Boston) and gave us pictures that were both fascinating and thrilling. But it must be really something to watch them if you have been closely tied in to the actual program. . . . From **William T. Barry, Jr.** "I did use my Course IV two years for backup knowledge when lecturing and teaching engineering drawing and graphics at Northeastern night school (Lincoln College Division) for 11 years. I have also kept up my WW II weather interest by teaching the Power Squadron class in weather in Portsmouth, N.H. If any classmates get into Boston with free time I can be reached by phone (466-3706) at the State Street Bank and Trust Co. where I am an assistant trust officer." It's nice to see another classmate active in the Power Squadron and I know that weather course is one that really benefits from actual meteorological experience.

Very briefly **Paul Grueter** writes "Retired from the Corps of Engineers, involuntary, after 34 years on May 18, 1970." According to the latest Alumni Register, Paul had been Assistant Chief, Design Branch for the New England Division. . . . **Peter Kalustian,** who had been with Drew Chemical Corp., says "I am very busy as a management consultant and consultant engineer with major clients in Brazil, Canada, and the U.S. This new career is very stimulating and exciting and is making many new friends for me. My wife will accompany me on most of my trips." . . . I am sure that an interesting trip lies behind the note from Professor **Harold Adams** of the University of Indiana Medical School. It goes, "Recently (May 9-21) served as an international consultant for the World Health Organization in conducting a seminar and workshop for environmental health personnel at Belize, British Honduras." . . . There are several more that I will save for next time. So if you were thoughtful enough to send some notes and don't see them here—you're not being ignored. They will be appearing.

By the time you read these notes, summer will be a thing of the past. If you've had any interesting trips or seen some of your classmates in your travels, I'd be happy to hear about it.—**R. M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **G. G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

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One of the replies I received during my search for golfers was from **Dave Buckwalter** in San Manuel, Arizona: "I must admit that I am one of the guilty from the Class of '35 who have done little to maintain the tie that binds one with his old classmates. If golf will strengthen the thread, I shall be glad to try it. However, if there is anything that is going to give me ulcers, I am certain that it will be golf.

Most of my spare time has been spent in the hills fishing, hiking, skiing, and picture taking. I had always believed that there would be time for golf when I was too old for the strenuous activities. Now that the time has come during the last couple of years I find that golf seems to be unconquerable, at least for a weekend player. My handicap of 24 testifies to this. We play in Tucson which is 40 miles from San Manuel. We are 125 miles from Phoenix. I have been successful in promoting a golf club in San Manuel, a nine hole course which will be ready in August. It will be a nice facility for this mining town of five thousand people.

"When you are in Arizona next month, I would be pleased to show you one of the more important installations which supplies the copper for the electronics industry. We are presently engaged in spending some 250 million dollars expanding this operation. This work is nearly completed but we must now embark upon another fifty million dollar expenditure to eliminate the sulfur dioxide from our stacks. It is my duty to shepherd the engineering and construction of this work. Perhaps we might even get out for a game of golf." Dave, I am sorry things didn't work out in my west coast June trip but I expect to spend some time in Phoenix in January and hope we can get together then.

A batch of notes came through the Alumni Fund office from several '35ers as follows: **Jack Holley** writes from Imperial Beach, Calif.: "Doing very little these days, heart seems to be OK. I'm advised not to take up scuba diving so depend on friends for a balone. Fishing and clamming, both good—still collecting rocks. My four wheel drive takes me wher'ere I yen. Haven't seen the grandchildren for almost a year but at last reports the 13 are all healthy." . . . **Phil Rhodes** writes from Cincinnati: "Now in my third year at Emery Industries, Inc. heading a small research group on P.V.C. stabilizers after having sold my own business out. Son Phil, Jr. is an electronics engineer living in Texas and two grandsons, Phil III who is 15 and Henry who is 11. We've been living in the same old house in Cincinnati since July 1952 and keeping it in repair seems to be my present hobby with some genealogy thrown in." . . . **Fred Lincoln** writes from Warwick, R.I.: "Same address but a new job. After 35 years with one company (Allied Chemical) I took early 'retirement' and went to work for one of my customers, E. and F. King and Co., Norwood, Mass. as sales manager. We are quite involved with chemicals for waste treatment, etc., so we have been real busy but I am hoping to spend more time at Cape Cod this summer." . . . **Anthony Guarino** writes from Rockville, Md.: "Attending International Technical Meeting in London May 19 through 28, 1971. I am U.S. National Leader (Army, Navy, Air Force) of Quadripartite Committee (U.S., U.K., Canada, Australia) on fuzes and initiators."

Paul Germond's news originates in Englewood, N.J.: "Ellie and I just returned from a most pleasant month in England, Wales and the Channel Islands. Still at the old stand making material handling equipment at the Revolvator Company." . . . **Bob Goodman** says: "I am chief engineer of Fairchild Industries, Industrial Products Division, Winston-Salem, N.C." . . . **Leo Beckwith** reports that daughter Lola is getting married in the fall.

A June issue of the *Chicago Tribune* had an article on the substantial expansion in indoor tennis. It was written by **Al Alschuler, Jr.,** long-time resident of Highland Park, Ill. and currently chairman of the U.S.L.T.A. Facilities Committee.

Thirty-fivers at the Alumni Homecoming included: Randy Antonsen, Rufus Applegarth, Leo Beckwith, Ned Cullins, Bob Forster and Allan Mowatt. Those accompanied by their wives included: John Alden, Dick del Etoile, Peter Grant, Oliver Hoag, Walter Johnson and Dave Terwilliger.

Now for some news on the golf situation. The four senior finalists in the Class Tournament are: **Ham Dow, Leo Beckwith, Sam Brown** and **Allan Mowatt.** First round activity featured a hole-in-one by **Bill Bates** on his home course near Pittsburgh—the first one in the 11 years of the Class Tournament. In Ham Dow's Member-Guest we tied with two other teams at 123 after two rounds of best-ball play. Ham proceeded to par the two sudden death extra holes and we won our flight. A great time was had by all.

Doreen and I were guests of Edith and Ham Dow at the Villages only a few days after they returned from Tucson where Merrilyn was married. Festivities of the second Annual Evergreen Invitational (Member-Guest) included a dinner-dance on Saturday evening at which the awards were presented. A few days earlier Doreen and I stayed with Verna and **Gerry Rich** in Santa Cruz. My business travels this past summer have enabled me to play golf with **Dick Bailey** in Kingsport, Tenn., with **Ellis Flink** at Providence, R.I., with Sam Brown in Short Hills, N.J., with **Les Brooks** at Norwalk, Conn., with **Bill Bates** in Pittsburgh, with **Sid Grazi** in Denver and with **Art Marquardt** at Brae Burn. It has been great fun renewing acquaintances, seeing old friends and generally catching-up with what had been happening. I highly recommend the activity for anyone who can arrange it.

Some address changes worth noting: Paul Daley is now living at 1813 S. Shore Dr., Holland, Mich.; Thomas K. Graham is now at 46 Conover Lane, Red Bank, N.J.; Jack Colby is back in Wisconsin for the summer at N.6005 W.347 Lake Dr., Oconomowoc.

I hope and trust you are all getting renewed energy with the arrival of cooler weather and that this may spur you on to drop me a note. A happy fall to you and yours.—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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Forty members of the Class, many accompanied by wives, attended the Reunion in June. Of these, 14 went on to Cambridge for the Alumni Homecoming events and were joined there by 13 additional members. Names and information gleaned will be included in future notes.

The long summer hiatus has resulted in an accumulation of miscellany which I wish to share with you. **Philip Slater** has been elected president and chief actuary of Woodward, Ryan, Sharp and Davis, Inc. in New York City. His daughter Eve has received her M.D. and is an intern at Massachusetts General Hospital. . . . **Stephen Richardson** is senior partner and director of The Richardson Associates, Architects/Engineers/Planners. **Walter Seinsheimer** continues as an arbitrator of labor-management disputes. He was the author of an article titled "Easing the Arbitration Traffic Jam" which appeared in *Personnel* Magazine. . . . **Leonard Cohen** reports that he retired from Lockheed Aircraft and moved to the Ford Motor Company in Dearborn as Principal Engineer for the Reliability, Systems Engineering, Product Development Group.

Larry Sharpe reports that he spent last winter in Florida and sounds as though he expected to continue the practice. . . . **Earle Anderson,** on the other hand, has moved to the Bahamas where he has bought a home and guest cottage at Hopetown. The guest house is available! . . . **Al Bagnulo** has been in Sydney, Australia managing the construction of a mining operation, a railroad, coal storage and docking facilities for CLUTHA Development. His wife Helen reports that he is enjoying both the people and the work.

Frank Berman's daughter was married the weekend of our reunion, **Mal Holcombe**'s daughter graduated from college at the same time. . . . **Stan Johnson** reports that he is using every spare minute in building a summer home on a lake not too far from Pittsburgh where he is with U.S. Steel. . . . **George Trimble,** President of Ramo, was out of the country in early June.

It is my sad duty to report the death on July 11, 1971 of **Donaldson R. McMullin** of Weston, Mass. He had been in poor health for some time. Our sympathy goes to his family and associates, and as well to **Dick Halloran** on the passing of his wife and to the **Ben Coopersteins** who have lost a young daughter.—**Alice H. Kimball,** Secretary, 100 Memorial Dr., Apt. 8-6C, Cambridge, Mass. 02142 or P.O. Box 31, West Hartland, Conn. 06091

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Our class was represented at Alumni Day this past June by the following members with their wives: Bert Bennison, Joe Heal, Les Klashman, Phil Peters, Bob Thorson, Ralph Webster and Walt Wojtczak, plus Walt's daughter, Carolyn. It was great fun renewing friendships and everyone was planning on attending our 35th reunion next June at the Chatham Bars Inn on Cape Cod.

Richard Ewert, President of the Sewall Gear Manufacturing Co., St. Paul, Minnesota was recently elected president of the American Gear Manufacturers Association for the coming year. **Evan Edwards** has been named Assistant Director of the newly formed film technical service division of the Eastman Kodak Co., Rochester, New York. Evans has been a Kodak employee since 1948. . . . **Joe M. Engel** has been appointed assistant chief

metallurgist by the Republic Steel Corporation. Joe joined Republic in 1939. He has been assistant district manager at Chicago since January 1968. . . . **Paul A. Vogel** has retired to a 1795 Maine Colonial House (South Windham). He is traveling throughout the United States and Canada raising funds for a Unitarian Universalist Theological School.

Norm A. Birch has recently removed to 1813 Fourth St., Jackson, Mich. 49203. He and Elvie should be grandparents by the time these notes are published. . . . **Ralph Chapin** is heavily involved in "Citizens for Ecological Action" and reports that he is learning a lot of things we weren't taught at the Institute. He expects it is different today. His son returned after years in the Regular Army followed by working in Germany. He brought a German wife and little girl home and now has added a son.

Mort Nickerson has retired and separated from Arthur D. Little Inc. where he has been for the past 12 years. He sold his home in Winchester, Mass. and now lives in Enfield, Conn., besides owning a lovely old (200 years) house in North Truro on the Cape, where he now spends his summers. His daughter Gail is married, and is living outside Washington, D.C. His son, Craig, is working around Boston.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Curtiss Powell,** Assistant Secretary, Rm. 5-325 M.I.T., Cambridge, Mass. 02142; **Jerome Salny,** Assistant Secretary, Egbert Hill, Morristown, N.J.

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M.I.T. Alumni Homecoming Day was a great success. I was supposed to attend but had to cancel out at the last moment. In attendance were the following: Mr. and Mrs. Bob Bowie, Mr. and Mrs. Given Brewer, Frank Gardner, Mr. and Mrs. Saul Jacobson, Mr. and Mrs. Bob Johnson, Mr. and Mrs. Norm Leventhal, Mr. and Mrs. Paul O'Connell, Mr. and Mrs. Don Severance, Mr. and Mrs. L.S.S. Smith, Paul J. Sullivan, Ben V. Thompson, Mr. and Mrs. Ed True, Mr. and Mrs. Joe Vallone, Al Wilson, Jr.

When you make your contributions to the M.I.T. Alumni Fund, if you will jot down a few notes on the return envelope, it will eventually reach me for inclusion in the class notes. . . . Some of the notes received recently include a report from **Dick Henderson** who states that he is now Director of the Environmental Hygiene and Toxicology Department, Olin Corp. Dick is also president of the Nutmeg Section, Institute of Food Technologists, and is president of the New England Section of the American Industrial Hygiene Association. . . . **Boris Boguslavsky,** retired as civil engineer from the Arabian American Oil Co., Saudi Arabia in September '68. He was a visiting professor of civil engineering at the Virginia Polytechnic Institute, September 1968-June, 1969, and a professor of engineering graphics at Louisiana State University ever since. He further reports his manuscript "Computer Programming in Fortran IV" in review by publishers. . . . **Walter Johnson** writes that he recently relocated from Jackson and Moreland, Consulting Engineers, Boston, to Digital Equipment Corp. in Maynard, where he holds the position of mechanical engineer in the plant's engineering department. . . . **Bill Gibson,** who retired from the Foreign Service in 1965 after 25 years, went back to school for an M.A. in economics which he received from the American University. He is now working with the H. and R. Block Executive Tax Service, and Seaboard Planning Corp. and Seaboard Life Insurance Co. while waiting for a job as an economist. . . . **Dave Pearlmutter** writes that he is teaching high school chemistry.

Another gimmick that I use to tease news from you fellows are the return postcards when M.I.T. notifies us of the change of address. Some samples of recent replies include a card from **Dave Torrans** who informs us that he is now technical superintendent at Hercules' Lake Charles, Louisiana plant. . . . On the same day, I also had a card from **Curtiss Torrance** who reported that he is still with Charles T. Main, Inc., but has moved to a home on a 33,000 acre lake so he could spend more time sailing and swimming. . . . **Nick Barbarossa** writes that he has fulfilled his wife's childhood dream concocted in, of all places, International Falls, Minn., by moving to the State of Virginia to accept a position as regional leader, Central Region, U.S. Water Resources Council Washington, D.C. This job will entail travel all over the U.S. for almost half the time. Nick presently has five daughters, four of whom are married, and five grandchildren. . . . **Arthur Gold** writes that he is the manager of Q. C. Systems, M. T. and G. Department of General Electric Co., and is the secretary of the Lynn Lodge, B.P.O.E. He spends most of his spare time sailing, and makes a hobby of genealogy, particularly of Acadiens. **Bob Flynn** sent in a card indicating that he is still practicing patent law in New York as a partner of the firm of Flynn and Frishauf. . . . **Doc Wochos** writes that he has finished his third year as president of I.T.T. Cannon. He adds that he is leaving to start a new venture, but did not let any cats out of the bag. . . . **Al Clogston** has just moved to Albuquerque, New Mexico as vice president for research, Sandia Corp., on leave from Bell Laboratories. He is having a grand time learning to know the Southwest. He further reports that he has spent a lot of time recently on committee work, working on problems of physics as a profession and on problems of science and engineering education. . . . A card from **Norris G. Barr** gave no information other than his new address: VA-PN 125, Javea (Alicante) Spain.

Your secretary was recently elected treasurer of the New Jersey State Society of Certified Public Accountants. . . . The last item this month is a quote from The *Environment Monthly:* " 'Like Standing on Your Head—Easy If You Know How.' Environment comes in many forms, some of them improbably—such as this weekend retreat which won a Design In Steel Award for the architectural firm of **Harry Weese.** It juts out from the face of a 150-foot limestone cliff rising above the shoreline of Lake Michigan. And to tell the honest truth, the design would have been unthinkable without the six two-feet by two-feet steel bars from which the steel and glass enclosure is suspended." —**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney and Co., 140 Broadway, New York, N.Y. 10005

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Class Treasurer, **Ernest R. Kaswell,** president and a founder of Fabric Research Laboratories, a textile research firm headquartered in Dedham, Mass., has been named the 1971 recipient of the Olney Medal of the American Association of Textile Chemists and Colorists. This medal is the association's highest recognition for technical and scientific

E. Kaswell, '39

R. Dorsey, '40

J. Libsch, '40

contributions to the advancement of textile chemistry. . . . **Willard F. Babcock,** Professor of Civil Engineering, North Carolina State University at Raleigh, was one of 30 faculty members chosen by their students and recent alumni as Outstanding Teachers for 1970/71.

Harold Chestnut has been nominated for 1972 I.E.E.E. vice president. . . . **Richard P. Feynman,** Cal Tech, was described in *Physics Today,* February 1971, as one of the leading contributors to the concept of the "parton", a term used in studying atoms, nuclei, and nucleons. . . . **Charles J. Jeffus** wrote that he is an instructor in Electromechanical Technology at the W. W. Holding Technical Institute, at Raleigh, N.C. . . . **David G. Kaufman** left the Davis and Geck Division of American Cyanimid where he served as technical director, in June of 1968, and is now chief of biomedical services of Maimonides Medical Center, Brooklyn, N.Y. . . . **Moses Cammer** is currently an officer and chief engineer of Metalcrafters Specialties Inc., Larchmont, N.Y., manufacturers of automobile bumper guards and burglar alarms.

Attending the Alumni Homecoming festivities in June were the following, each with his wife: Henry Bagley, George Beesley, Robert Casselman, Gus Griffin, William Hawthorne, Harold Hindman, Ernest Kaswell, John Krey, William Pulver, and Reevan Spiller.

We have received with sorrow news of the passing of three classmates: **Wilbert C. Gumprich,** on March 22, 1971, in Lynchburg, Va., **Abraham M. Potter,** on February 15, 1971, in West Hempstead, N.Y., and **Nelson S. Griggs,** on May 22, 1971, in Montpelier, Vermont.—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Pa., 18017

40

Theodore Snow ('39) has kindly written to correct an error in the June column reporting the death of George Stoner: "May I correct and update your report of June on George Stoner? Following 1964, George was vp-general manager to the aerospace group of Boeing and then senior vp-operations of the corporation. He may have had some connection with Sunbeam Corp.—though I don't believe it—but he never left Boeing. George was a man of tremendous energy, brilliance and imagination who contributed greatly to the nation's space and technology efforts. His passing was a great loss to Boeing as well as to his family and friends." . . . **John Joseph,** one of our selfmade men, writes, "I get down to Washington once a month now since I am on the National Executive Committee of Americans for Democratic Action. I am also New Jersey State Chairman and a member of the National Foreign Policy Commission. Besides manufacturing my Blockbuster toy blocks these last 20 years, plus real estate and security investments, I spend my free time sailing, skiing and as a passionate activist 'dove,' with all kinds of liberal, but non-violent organizations. This has made me famous or infamous, depending on your point of view. Currently, I am under indictment for flag defamation. After the Cambodian and Kent State affair, I flew my flag upside down with a bloody rag attached. After six years of being with the minority, it is nice now to find myself with the majority and to have been proven right by the Pentagon papers. Louise and I get rid of the last of three-fold parental responsibilities on July 4, when Jean marries Mohan Kumar, an electrical engineer with a master's in business management, and takes an around-the-world honeymoon trip, including a visit with his family in Madras. I hope to have news of a new venture I plan for nationally franchising a much needed service to attorneys when I next write. I commute by elevator to my office, and classmates are welcome at 147 Berkshire Rd. to see the only house in Hasbrouck Heights, N.J. with such a contraption, as well as a steam bath, central vacuum cleaning and bidet."

Bob Dorsey, who is manager of the lighting development with a large lamp department of G.E. in Cleveland, Ohio, has been elected senior vice president of the Illuminating Engineering Society for 1971-1972. Bob is the patentee of a number of patents in the lighting area. . . . **Joe Libsch** has been honored for 25 years of service on the faculty of Lehigh University. . . . **Norm Klivans** is now vice president of Auctor Associates, Inc., a new consulting firm in the field of technology management; formerly he was corporate vice president and group executive for electronic operations of Gould, Inc. . . . A number of classmates have been kind enough to send brief notes on their recent activities: **Clement Burnap**—"Your pledge reminder of May 14 reached me in Perth, Australia June 23 due to insufficient postage to get it to London before we left May 28. Mrs. Burnap and I are 'working!' our way home visiting customers and licensees for Paceco Container handling cranes. Our path has been Paris, Nantes, Rome, Casablanca, Nairobi, Johannesburg, Kruger National Game Reserve, Mozambique, Malagasy, Mauritius, Perth, Adelaide, Melbourne, Sydney, Bali, Jogjakarta, Djakarta, Singapore, Hong Kong, Taipei, Tokyo. Hope to get back to San Francisco to assume my new position in charge Paceco foreign operations by August 1!"

Russ Haden—"Resigned as president of Ionics in March. Am now looking for a small company to buy or a tremendously interesting job for my declining years." . . . **Jo-Jo Wiley**—"Went to my son's graduation from Harvard recently and found the place a terrible mess. Very glad to see him out of there. He (J.B. the third) has since married a lovely girl, Phoebe Wheeler of Washington, D.C., and they are in the Peace Corps together." . . . **Ted Gundlack** supplies statistics (how true they are)—"Three kids, all through college and married, including sons and daughters-in-law; my formula is: one D.D.S. + two M.S. + three B.S. + one four-year army hitch = 0 (Dad is broke)." . . . **Bob Nedell** sends the news, "Still a consulting engineer, as president of Nedell, Locke and Associates, Inc., Consulting Engineers, Denver, Colo. Sorry to have missed 30 year reunion in 1970, but hope to make next Alumni Day. Oldest son, Rick, graduating this June as a sanitary engineer, planning to continue towards his master's in civil engineering. Middle son, Jeff, a freshman at Ft. Lewis College, Durango, Colo. Youngest son, Steve, finishing his junior year in high school. Wife, Harriette, busy as mother and wife. Enjoyed the recent visit of our president-elect, Jerome Wiesner. Regards to all 1940 Course I graduates."

John Quady writes, "In May of 1970 I joined the Rohr Corp., Chula Vista, Calif. as program manager—advanced marine vehicle systems. I was recently promoted to manager of advanced systems engineering, working on introduction of new concepts leading to new product lines for Rohr." . . . And from **Larry Jones** comes the note, "I'm now president of

Kenneth A. Roe, '41

Pure Water Processing, Inc. We've cleared up pollution in some ponds and are now ready to undertake lakes. We don't use the mechanical or chemical methods now used." . . . Our classmates and spouses at homecoming in June were: Ed and Mrs. Bernard, Mr. Bob Bittenbender, John Danforth, Richard and Mrs. Gladstone, Russ and Mrs. Haden, Herb Holloman and Phil Stoddard. Write your class secretary—**Alvin Guttag,** Cushman, Darby & Cushman, 1801 K Street, N.W., Washington, D.C. 20006

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Kenneth A. Roe, President of Burns and Roe, Inc., International Engineering consultants, was recently installed as president of A.S.M.E. Ken lives in Greenwich and summers, when not travelling, on Nantucket Island. Ken and his wife Hazel attended the 30th reunion in June. Ken received his S.B. in chemical engineering after having received a B.A. from Columbia. He followed this with a M.S. in mechanical engineering at the University of Pennsylvania. During the war Ken served in the Navy. He is a registered professional engineer in 26 states. Ken and his father, R. C. Roe are fellows in A.S.M.E. and his son, K. Keith, is an associate member. It is probably a unique situation to have three generations represented at the same time. One of Ken's sons, who is currently following the footsteps of his father with a tour of duty on the U.S.S. *Wallace L. Lind,* expects to do graduate work at Tech before rejoining the company.

Ken became president and chief engineering officer of Burns and Roe in 1963. He has been engaged in the design and engineering of numerous power plants—both nuclear and conventional. His work has also involved him in Project Mercury, the initial man-in-space program, and various other programs for N.A.S.A. . . . In addition to the three elder sons, Hazel and Ken have a daughter, Hollace, a sophomore at University of Denver, and a fourth son, Barton, a sophomore at Suffield Academy. Ken belongs to the Sons of the American Revolution, the Founders and Patriots Society, and the Round Hill Community Church. For recreation Ken and his family enjoy golf, tennis, and sailing. During the season he and Hazel are regulars at the Met and the N.Y. Philharmonic Orchestra concerts.

Albert Bowker, well-known at City University in New York, has accepted the position of Chancellor, University of California at Berkeley. It is apparent that Albert accepted the job because of its immense challenge to him as an educator. When asked why he was going to Berkeley he replied that the chance to lead "one of the greatest academic institutions" was "an opportunity I could not turn down." His return to the coast will renew many old friendships, as he was on the Stanford faculty from 1947 to 1963. Many of those he recruited while building the Statistics Department to a position of national prominence are still there. It is interesting to note that California's president, Charles J. Hitch, recommended only one man to the Regents when Chancellor Roger W. Heyns retired—Bowker. No doubt the impact of Bowker's philosophy and ability (he increased C.U.N.Y.'s enrollment to 195,000) will soon be felt on the west coast.

E. Kirkbridge Miller has recently been elected Chairman of the Board of Rowe Price Management Co., Inc. Kirk received his S.B. at Tech followed by a stint in the Navy. During his tour in 1943 he found himself up the river at Harvard Business School where he received one year's credit toward his M.B.A. He completed the degree in 1950 after operating his own business for a couple of years. This was followed by a year and a half with Western Maryland Railway, from which he resigned in 1952 to join Rowe Price. In addition to his duties with the parent company, Kirk holds the office of Director and Vice President of T. Rowe Price and Associates, Inc.; the T. Rowe Price Growth Stock Fund, Inc. and the Rowe Price New Horizon Fund, Inc.

Fred Kunreuther writes that he has left Shell Oil Co. to establish his own consulting business. . . . **Stan Marple,** still with Shell as Refinery Process Engineer, has moved from New York to Houston. . . . **Art Corvett** reports that his son, Marc, made it through M.I.T. with the Class of '71. . . . Going to M.I.T. used to be for men only, or almost so. Now with the wonderful dorms for girls, the co-eds are becoming more numerous, and our class is contributing to the situation: **Jim Gordon** says his daughter, Jennifer, will enter in September with the Class of '75, and **Albert Parsons** states his daughter, Judith Anne, is entering this fall to study civil engineering.

Carl Mueller's daughter Anne was married in June to Eric Redman of Seattle in the west side Presbyterian Church, Englewood, N.J. Carl, a general partner in Loeb Rhodes and Co., must be busy this summer as I have only seen him on the island a couple of times. . . . **Ed Marden** was down with his family a week ago and looked fine. I was making one of my reluctant trips to Boston so did not get time to talk.

A recent release from M.I.T. indicates that **Robert M. Fano** has been appointed Associate Head of the Department of Electrical Engineering for Computer Science and Engineering. Bob, you may remember, was in charge of organizing Project MAC and served as its Director from 1963 to 1968. After graduating from Tech, Bob worked in the Radiation Laboratory and in 1947 received his Sc.D. in electrical engineering. From 1950 to 1953 he was at Lincoln Lab as a group leader in radar techniques. In 1956 he was appointed Professor of Electrical Communications and in 1962 became the Ford Professor of Engineering. He is the author of *Transmission Information* and has co-authored two other texts on electromagnetic theory.

We had hoped to report the 30th reunion this issue but seem to have little space. Next time out we will have it.—**Michael Driscoll,** Secretary, P.O. Box 1348, Nantucket, Mass. 02554

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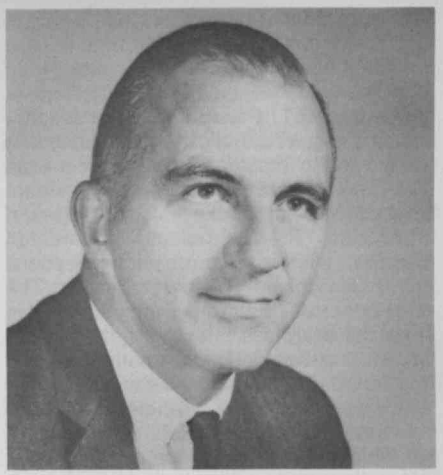
Dr. **Morris Steinberg,** deputy chief scientist of the Lockheed Aircraft Corporation was one of the speakers at the "Los Angeles Decarama" lecture series at U.C.L.A. in May. Moe told of serious and sustained efforts by the aerospace industry in such areas as high speed ground transportation, communication and information systems, water purification and regional development. However, he said that many aerospace companies have had unhappy and expensive experiences in nonaerospace programs where technical feasibility was proven by outside support, including government interest, as lacking. The problem, according to Dr. Steinberg is ". . . that the market for these activities does not exist at all or, if it does, it is so highly frag-

Charles J. Lawson, Jr., '43



mented that it can be cultivated only at costs too great for any private organization under the present circumstances."

Jim Girdwood has founded the Intelligence Company in Denver and is operating in executive personnel consulting, merger and acquisition negotiations and in turn-around management. . . . **Edgar Wise** writes that he is still engaged in high pressure research with Union Carbide at South Charleston, W. Va. . . . **Chester Kuczun** is now president of Tri-Con Associates, Inc. in Boston. . . . Note from **Frank Seeley** who is with Aerodex at Miami Airport, "Hope to see more of the old gang as we are reaching our golden years!" Frank, aren't you rushing things a bit?

Dick Gillooly is deputy director of Airlock at McDonnell Douglas in St. Louis. Recently **Jack Cantlin** visited with Dick and toured the facility where the airlock portion of Sky Lab is being assembled. . . . Captain **Harry Maynard** U.S.N. (ret) is manager of the Bellevue (Washington) Chamber of Commerce and was elected president of the Bellevue Rotary Club this year. . . . **Charles Estes** is presently manager of Government Systems at Motorola in Scottsdale. In his previous job as manager of the Telecommunication Lab, Charles was associated with the development of space electronics systems for the Mariner, Gemini and Apollo programs. . . . **Bob Keating** is financial analyst and group controller in the corporate finance department of Atlantic Research Corporation in Washington. Atlantic Research was recently merged into Susquehanna Corporation and Bob specializes in analysis of mining and milling operations such as the processing of uranium concentrates for the commercial nuclear power market.

There was a large turnout of 42'ers at the Jerome Wiesner meeting of the M.I.T. Alumni Center of New York on June 30. Saw Alan Katzenstein, Bob Kraus, Bernie Levere, Floyd Lyon, Adrian Marcuse, Geza Neuman, Bill Van Nostrand and Eric Wormser. President Wiesner's remarks are doubtless reported elsewhere in the *Review* but as usual they were interesting, witty, clever and meaningful. . . . The Class was represented at Alumni Homecoming by Dick Gibson, Bill Denhard, Jack Lacy, Sumner Lewis, Joe McHugh, Bill Pease and Maynard Renner.—**Ken Rosett,** Secretary, 191 Albemarle Road, White Plains, New York 10605

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The Summer slipped by with a bit of news from here and there, which we'll pass along to you. Senior Secretary **Jack Kelly** was travelling in the Far East, but no report on his trip yet. **Andrew Granese, Jr.** wrote that he left the bachelor ranks in 1969, and married Sandra Louise Kenney from Concord and LaSalle Junior College. They now have a baby girl, Elizabeth Mary, born July 4, 1970. He has been with Raytheon Co. for the last 14 years as materials and process engineer. Charles J. Lawson, Class of 1920, sent in some notes to his class secretary which were routed to us, concerning his sons, **Charles J. Lawson. Jr.,** '43, and James T. Lawson, '44. Charles Sr. retired from the United States Air Force in 1957 and from I.B.M. in 1962; he winters in Naples, Fla. and summers in New London, Conn. Our classmate, Charles, Jr. is president and a director of Rotron, Inc. of Woodstock, N.Y., and James T. is president of Ultronic Systems, Inc., a division of G.T.E.

Gilbert Gould wrote us in May: "The professional lay off hit me too—for nine months. I am working as an electronic engineer for the Air Force Northern Communication Area, headquartered at Griffiss Air Force Base, Rome, N.Y. Also, as an aside, I am involved in a new company, Knightbridge Industries, Inc., as a member of the board of directors and professional engineering consultant. My family is well and active and spread all over the map: Jim, Brad, Barb and Sue in Texas, New Hampshire, Vermont and New York respectively as an Air Force jet pilot in training, an electrical engineering student at University of New Hampshire, a freshman at Middlebury College, and an active high school junior and cheerleader. My wife, Ellie, obtained her master's degree in library science last year at Syracuse University and is now a librarian in a local grade school."

The June reunion was highlighted by a class cocktail party at the Faculty Club, attended by about 20 classmates, many with wives and/or sweethearts. **Howie Mattes** planned the affair with help from **Jim Hoey, Jr.,** and another is on the docket for next June. Many of us had dinner together after the affair, at Charlie's Place in Boston. Only the Boston area men were invited, but next year all will be.—**Richard M. Feingold,** Secretary, 266 Pearl St., Hartford, Conn. 06103; **Jack Kelly,** Associate Secretary, 34 Scudder Rd., Westfield, N.J. 07090

46

I hope all of you had a pleasant and relaxing summer. We would assume many of the Class are now busy with raking the leaves or watching the football games, either at the stadiums or on television. Pile the leaves a little higher, or put another log on the fire if you are inside and I will spin you the tale of the 25th Reunion.

It was a grand reunion, and those of you who did not or could not attend the reunion missed a fine affair. The reunion began on Friday, June 4, with people arriving from noon until late evening. Most of the Class and some of the children were housed at Baker House. A majority of the children were housed in other dormitories as were a few of the Class and their wives. A total of 57 classmates and their wives, and approximately 140 children were registered. Friday evening began with an excellent buffet dinner served in the dining room of Baker House. Counselors were assigned to each age group of the children, and after dinner they began their programs of games, swimming and other activities. These excellent counselors kept the children occupied each day from breakfast until bedtime each evening. The class members and their wives attended a cocktail party following dinner, with the opportunity to talk more completely with many whom we had not seen in a long time. Most of us went to bed by midnight, but I suspect there were a few who continued the party for a few more hours.

After breakfast at Baker House the Class gathered for a seminar and panel discussion with four faculty members. The panel explained the recent happenings at M.I.T. in detail, and reported on the future as they saw it. These predictions and plans covered nearly all the aspects of campus life, curriculum, faculty, laboratories and the alumni. There was a question and answer period with questions from both our class and two other classes who also attended this meeting. I believe most of us were interested, relieved and pleased by these plans and predictions. The discussion actually carried past the allotted time by

nearly an hour, which gives some insight into the interest the alumni had in this meeting. At 12 o'clock we all met again at a reception at the president's house, given by M.I.T. President Howard Johnson and his wife. Following the reception we moved to Walker Memorial where we met for an excellent lunch. President Howard Johnson spoke to our group and introduced President-elect Jerome B. Wiesner, who spoke of his aspirations and plans for M.I.T. in the future. The remainder of Saturday afternoon was spent by the class members playing tennis, touring Boston in especially assigned tour busses, or just plain resting.

We began the early evening at a cocktail party at the new M.I.T. Student Center. This party featured some of the most interesting and well presented appetizers I have ever enjoyed at a party. After an hour or so we drifted down to the Sala de Puerto Rico room for dinner and dancing. During the band intermission we moved to the Kellogg Auditorium for a presentation by a local theatrical group, "The Proposition." They were a talented group of four, two men and two girls, who did musical sketches and stories based on name, objects, characters and plots suggested by the audience. Everyone was quite taken by them and their refreshingly different form of humor.

Sunday began with breakfast and church. Beginning at 11:00 a.m. buses arrived to take us, the children and their counselors to the Essex County Club, located out the North Shore way. For the early arrivers there was golf and tennis. Our gang arrived with the last group, just as the clambake was beginning. I must admit to eating six clams and three wonderful two-pound lobsters. My wife, Mary, is not a clam fan, but she loves lobster as well as I, and she was able to eat two lobsters. I doubt if many of the group did not eat at least two lobsters as they were delicious and very plentiful.

Predictably a call went out for a father-son baseball game before any of those lobsters could be digested. A myriad of small boys and heavy set men moved toward the diamond. The Class can be very proud of those of us who played that day. Not only did we win and spike those nasty remarks that we were over the hill, we thrashed those 12-year-olds 24 to eight, or something like that. No true or complete evaluation of the score can ever be made. Great care was taken to assign the scorekeeping to class members proficient in mathematics, but alas they also proved proficient in drinking. The star of the game had to be **Bob Spoerl.** Bob was a roaming catcher—infielder—outfielder, and was constantly in motion helping everyone cover their positions. He made several sparkling plays and committed but two errors, both occurring when he stumbled over the many empty and full cans of beer he had cached near second base. At the conclusion of the ball game the buses returned us to Baker House for a change of clothes, a quick supper, and then to the Boston Pops and M.I.T. night at the Pops.

So as to dispel any thoughts that we did not have our serious moments I wish to report we did hold a class meeting which lasted nearly 30 minutes. The new class officers elected at this meeting were as follows: President—Ned Tebbetts, Class Agent—Ted Heuchling, Vice-Presidents—Jim Goldstein, Bill Schield and Glen Dorflinger, Secretary—Russ Dostal, Treasurer—Ken Davis, and 30th Class Reunion Chairman—Bob Spoerl. This meeting enthusiastically congratulated and thanked Ned Tebbetts, the 25th Reunion Chairman, and his fine committee for this wonderful 25th reunion. There were many on this committee who deserve great praise for the work that each did and again for the Class I wish to say, "thank you", to all of them.

One of the souvenirs of the reunion was a set of highball glasses commemorating this event. There are a few sets remaining which can be purchased at $8. per set. Checks should be sent to H. Oedel, c/o Spir-it, Inc., 115 Centre St., Malden, Mass. 02148. . . . Until next month.—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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This summer has certainly passed rapidly perhaps due to the cool weather in this part of the country. It has made golfing most enjoyable, though I haven't really been able to get my game going. Gina and I did put it together, however, for two rounds and won the club husband-and-wife championship with a 72-hole medal net of six under par.

The M.I.T. Club of Mexico had their 23rd fiesta in Mexico City this spring. It sounds as if it were a gala event. Attending from our class was Pedro Albin.

At Alumni Homecoming in June our class was represented by Mr. and Mrs. Claude W. Brenner, Mr. and Mrs. Thomas S. Crow, Mr. and Mrs. Harry C. Dedell, Jr., Mr. and Mrs. Kermit Greene, Mr. Robert Hagopian, Mr. and Mrs. Richard S. Mooney, Mr. and Mrs. Martin M. Phillips, Mr. William R. Page, Mr. and Mrs. Arnold O. Putnam, Mr. and Mrs. Jack Rizika, Mr. and Mrs. Norman L. Seltzer, Mr. Leonard W. Russum, and Mr. Donald M. Van Greenby, and Mr. and Mrs. Robert Danner.

The Corporation of the Institute has elected **Paul Cook** as a member to a five-year term. Paul is president of Raychem Corporation in Menlo Park, Calif. . . . . **Bob Peach** has been elected Vice President of the American Society for Quality Control. Bob is manager of Quality Insurance for Sears Roebuck. . . . **Ken Block,** President of A. T. Kearney, has been elected President of the Institute of Management Consultants. . . . **John Truxal** was the commencement speaker at the Indiana Institute of Technology and the recipient of an honorary Doctor of Engineering degree. . . . Dr. **Henry Lee** has started and will act as President of a new concern, Lee Pharmaceuticals, formed to develop, manufacture, and market products for dental restoration.

John Kellett recently wrote enclosing a newsletter of his activities dated September, 1970, which reads as follows: "I keep meaning to write you, and was finally moved to do so by reading the '47 Class Notes in the April *Technology Review.* The attached newsletter was written nine months ago, as you can see, but it's still pretty valid in describing what life is like here: "I am alive and well and living in Okinawa. I have now moved into my house and am pretty well settled. There is a view of the Okinawan village of Hiyagon and the Pacific and White Beach peninsula beyond. The Okinawan people almost without exception live up to the name of their country as 'Land of Courtesy.' The governments, both the U.S. Civil Authority of the Ryukyus and the Okinawan government of the Ryukyu Islands are a good example of the problems in military government of a foreign culture. The Japanese are active in getting ready to take over, but very little is visible yet.

"The life style here is of course very different from New York or London. The island and sea are beautiful. We have hired boats to go over to the coral reefs and small islands for swimming and snorkeling. I have only been to two concerts so far (one by the Okinawa Chamber Orchestra and Choral Society), but hi fi equipment is sold everywhere at low prices. Neighbors and colleagues at work are pleasant and helpful. I've been going to Japan about once a month, and hope to get to Taiwan and Hong Kong for a short vacation this fall. I still plan to take my annual leave in the U.S. and Europe next May and June. In the meantime, letters on what *you're* doing will be gratefully received. Our refinery project is coming along nicely—construction is about half complete, thanks to the excellent weather we have had all year. You have probably heard that the agreement for reversion of Okinawa to Japan was signed last week—after 20 years of campaigning for it, now the Okinawans aren't sure that they want it—or at least, not under the terms of the agreement. Things are never dull here." Thanks, John, for bringing us up to date. Let's hear from more of you.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

48

Sonny Monosson, President of the Class of '48, recently announced the appointment of **Jack Page** as Reunion Gift Chairman. Mr. Page's extensive record of helping M.I.T. includes two years of being president of the Dallas M.I.T. Club and Area Council Chairman in Dallas for the Alumni Fund. In his spare time, Mr. Page is vice president of Booz, Allen, and Hamilton's Dallas office.

Sonny is still recovering from the muscular strain of twisting Jack's arm, and Jack's arm will be out of the sling when the Class of '48 totals up its 25th reunion gift in June, 1973. While Sonny was twisting one arm, **Ken Brock** immobilized Jack by holding Jack's other arm. Jack has mailed a brief questionnaire to the members of our class to determine each classmate's intentions about attending the 25th Reunion and helping make '48 the Megabuck class. If you haven't returned your questionnaire, your help in taking a minute to do so would be ap-

preciated. Jack invited Sonny, Ken Brock, **Verity Smith, Dick Harris, Ted Yoos** and me to a meeting in July to review the goals for our Reunion Gift. The goal is one Megabuck.

As part of setting the goal for our gift, we identified the equally important goal of planning a class reunion for June, 1973 that would provide the opportunity to bring the Class together in a manner that would attract 1,000 classmates whose current interests are much more diverse than the interests of the 1,000 men and women who earned a degree from M.I.T. in 1948. As usual in such a discussion, many blue-sky suggestions were made about the type of reunion that should be planned.

One possibility that merits further investigation was to arrange for a cruise ship to house the Class in Boston Harbor and serve as the hotel and activities center of the reunion. A cruise at sea outside the three-mile limit from Saturday to Sunday morning would provide the opportunity for a wide variety of Saturday night activities. Accordingly, we would like to run the following ad: WANTED BY THE CLASS OF '48—ONE BOAT SUITABLE FOR SLEEPING 1,000 PEOPLE (preferably free of charge).

In June many members of our class attended Tech Night at the Pops and enjoyed a delightful program. Bob Bliss, Ken and Ann Brock, Nick and Mrs. Caldwell, Dick and Mrs. Harris, Ben and Mrs. Kessel, Walter and Mrs. Koltun, Leon and Mrs. LaFreniere, John Little, Bill and Mrs. McEwen, Sonny and Gloria Monosson, Oon and Nancy Noble, Malcolm Reed, Al and Mrs. Seville, Stan and Mrs. Shein, Verity and Mrs. Smith, George and Alicia Wayne, Backman and Mrs. Wong, and Ted and Mrs. Yoos, and Gloria and I attended all or some part of Alumni Homecoming Day.

The M.I.T. Club of North Jersey awarded **Jack Walch** the Volunteer of the Year Award. Jack works for Public Service Company in Newark. . . . **Jay Lathrop** is Professor of Electrical Engineering at Clemson University. Jay and his wife operate a riding stable near their home. Jay was recently appointed to the board of directors of Seaco Computer Display Corp., Dallas, Texas. . . . **George Lim** continues in his practice of orthopedic surgery, where his engineering background comes in very handy. One of George's medical hobbies is biomechanics, the application of engineering principles to orthopedic surgery and he has lectured on this subject to orthopedic surgeons. George is working with **Karl Justin.** '48, who is vice president of Max Urbahn Associates, New York City, architects for the expansion of Rome City Hospital in New York.

Theodore Thal is vice president and chief electrical engineer of Holladay, Eggett and Helin, mechanical and electrical consulting engineers, Los Angeles. . . . **Bill Nicholson,** Captain, U.S.N., retired last February. He took a long-planned extended ski trip to Switzerland, Colorado, and California. He has not decided on his future plans. . . . **Gerald G. Hatch,** President of Hatch Associated, Ltd., Toronto, is involved in mining, metallurgical and rapid-transit projects. **Ezra Garforth** resigned as president of Philadelphia Steel and Wire Corp. in September, 1970. He has joined Central Screw Co. in the Chicago area as executive vice president. Edna and Ezra moved west in June. . . . **Al Fioravanti** is with the University of Rochester Medical Center. He is very much involved with the construction of a new 50 million dollar hospital. His family (one boy, three girls) doing fine, love Rochester and enjoying their beautiful three-acre farmette. . . . **Walter Moore** has received his master's degree from North Carolina State University and he will teach math at Virginia Beach, campus of Virginia Community College System.—**S. Martin Billett,** 16 Greenwood Ave., Barrington, R.I. 02806

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Confusion always seems to be rampant when the time comes to put together the first column for the new school and publishing year. This year it is even worse, since I have changed secretaries and several newsworthy items appear to have been mislaid, including the list of attendees at the Class Cocktail Party on Sunday of June Homecoming Weekend. Despite all this, there is plenty of news, led off by eight notes from Technology Fund envelopes.

From **Frederick J. Beutler,** we have "since I have never contributed a news item before, anything I report might qualify as such. After leaving M.I.T. I spent several years in the aerospace industry. In 1954 I returned to school, receiving a Ph.D. from Cal Tech in 1957. Since then I have been on the faculty at the University of Michigan, where I am now Professor of Information and Control Engineering. I am also Managing Editor of *S.I.A.M. Journal on Applied Mathematics.*" . . . **Paul G. Miller** reports "new position last year with Control Data Corp . . . now vice president and group executive for marketing . . . responsible for selling the computer systems, products, and data services offered by C.D.C." . . . **Harold E. Rorschach, Jr.** writes "Frank, I am still chairman of the Rice Physics Department, and have one more year of it to stick out. I am looking forward to the 25th reunion—I hope to make that one. I have not got back to Boston in nearly 20 years. I'm sure I wouldn't recognize it (or you?)."

John W. Barriger confirms that he will be moving from Wayland to the Chicago area this summer as a result of his move from Sylvania Information Systems to rejoin the Santa Fe Railway last fall. . . . **Jack L. Baker** writes "now with Management Recruiters of Ann Arbor, in charge of industrial sales, technical, and manufacturing placements, after 20 years in design, systems engineering, program management, and industrial market research. Business is brisk for engineering and sales managers. We have a team of E.E., M.E., and a chemist. Good talent is always in short supply. Please write (2500 Packard Rd., Ann Arbor, Mich. 48104) or phone (313) 971-8700, especially if you will be visiting Detroit." . . . **W. Norris McSweeney** notes that he is still president of the Normac Company, Inc. and Normac Engineering, Inc., and is still treasurer of Chemical Control Company. . . . **Jeremy B. Lewi** notes he is "alive and well in Malibu, Calif. Seven years with Litton Guidance Division as advanced program manager in struggling aerospace industry—four children, many pets . . . wife who paints (very well) . . . involved in local affairs to preserve Malibu environment. Often see M.I.T. friends when they or I travel." . . . **Robert A. Arrison, Jr.,** writes "recently appointed vice president manager Nuclear Operations for the Picker Corp., manufacturers of medical instruments. Presently operating plant in North Haven, Conn."

David K. Hardin, President and Chief Executive Officer of Market Facts, Inc., Chicago, became president-elect of the American Marketing Association on July 1. Next year, after working closely with the current president, Dave will shed the "elect" status and become president. Congratulations, Dave. . . . Congratulations also, to **William S. Edgerly,** Financial Vice President of the Cabot Corp., Boston, who was elected in June to a five year term as member of the corporation of M.I.T.

Attending the Alumni Homecoming in June were the following: Mr. and Mrs. Ralph Belluardo, Andy Bigus, Mr. and Mrs. Gerald P. Dinneen, Mr. and Mrs. Fletcher Eaton, William S. Edgerly, Mr. and Mrs. Robert Hinrichs, Mr. and Mrs. Dean A. Horn, Malcolm H. Kurth, Mr. and Mrs. Arthur C. Loven, Mr. and Mrs. W. Norris McSweeney, Stanley V. Margolin, Mr. and Mrs. Lindsey R. Perry, Mr. and Mrs. Eugene B. Skolnikoff, Mr. and Mrs. Kemon Taschioglou, Alexander Vanderburgh, Mr. and Mrs. Paul E. Weamer, and Mr. and Mrs. Joseph Yamron.

Stan Margolin, President of the Class of '49, chaired the conference "Engineering and Social Costs in Environmental Control," sponsored by the Engineering Foundation and held at Deerfield Academy, Mass., the first week of August. The purpose of the conference was to discuss and work with approaches for engineers, economists, public office holders, and educators in determining social costs connected with protecting our environment, especially through engineering modification in processes and practices. . . . **Eugene B. Skolnikoff** head of the Department of Political Science, M.I.T., was one of 117 leading scholars, scientists, statesmen, and artists elected to the American Academy of Arts and Sciences in May. . . . **Paul E. Weamer,** Treasurer of the Class of '49, was elected president and director of Republic Foods, Inc., and Rowse, Inc., both of Greenville, N.H., processors and packers of drinking water, beverages, gelatins, desserts, vinegar, spices, and other food products. Paul has previously been associated with various New England food brokerage and manufacturing companies. Until recently, he was assistant vice president of Neal Mitchell Associates, of Cambridge. When I talked with him at Homecoming, Paul said he hopes to be able to get into the rapidly growing apple-wine market as one of his first activities.

Fred Pratt made the news in the *Boston Globe* this spring in a column by John C. Thomas of the *Globe* Washington Bureau

titled "Unemployed Technicians Lobby in D.C." Fred was one of 20 members of the Association of Technical Professionals from Greater Boston who went to Washington for three days of meeting with government officials and appearing before congressional committees. Fred and the others were representing about 10,000 unemployed scientists and engineers in Massachusetts and about 100,000 nationally. . . . Also in Washington, at a quaterly meeting of the Trustees and Officers of MITRE, **David L. Bailey.** Associate Technical Director, Air Transportation Systems, for MITRE, discussed details of the Federal Aviation Administration's ten-year planning for the development of Air Traffic Control Systems. . . . At a dinner meeting of the M.I.T. Club of Western Maine held in Portland in May, Professor **A. Scheffer Lang,** head of the Transportation Systems Division of the Department of Civil Engineering at M.I.T., gave a talk entitled "Transportation Systems Analysis and Transportation in the 1970's." Several students who will enter M.I.T. in September 1971 attended the meeting as guests of the Club.

Through the Alumni records, I have recently learned that **Thomas Ratti** of Colma, Calif. died on March 21, 1968.

As you settle down from summer and vacation-time to winter and the work-a-day world, give at least a passing thought to our Class 25th Anniversary gift and your share in it. We need $500,000. to fund a visiting professorship. This means increased giving by each of us in the remaining three years if we are to reach our goal. Hope each of you had a good summer. Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Rd., Concord, Mass. 01742

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Greetings from the Tall Corn State! After producing these notes for seven years, **Howard Levingston** has been promoted to President of the Class, and the undersigned was drafted to keep the good news coming. Other new officers elected at the reunion were **Gerry Marcus,** Treasurer; **Dick Reedy** and **Bill Maini,** Class Agents; **Breene Kerr,** Chairman of the 25th year Gift Committee; and **Nicky Alper, John Dowds** and **Sam Rubinovitz,** Associate Class Secretaries (Nicky for a second term). So much for the bureaucracy—here's the news.

Cardiologist Dr. **W. Gerald Austen** was president of the Massachusetts Heart Association this year. He is Chief of Surgery at Massachusetts General Hospital and Chairman of the Department of Surgery at Harvard Medical School. . . . **Jay M. Bernstein** is at the Electronic Systems Division of General Instrument Corp. and a trustee of the Plainview-Old Bethpage Board of Education. . . . **Richard C. Blanchard** has been with R.C.A. in Burlington, Mass. for 14 years. He gardens and sails his 30-meter sloop. . . . **Christian C. Bolta** has been working at Argonne National Laboratory for about a year. He has done nuclear work before and has been through rockets, ordnance, air pollution control and back to nuclear. Judging by the attractive penmanship on his card, Chris has taken up calligraphy as a hobby. . . . **Donald C. Brown** is a project director at Reynolds Metals working on an aluminum modular building system.

David Caplan is manager of transportation systems at Raytheon. One of their experimental projects was a "follow the flashing lights to Route 128", an elaborate computer controlled traffic merging (on-ramp to expressway) system. (He didn't say how it worked). . . . **William Cavanaugh** has set up a consulting practice in acoustics in Natick, Mass. He left Bolt, Beranek and Newman after 17 years. . . . **Garth Coombs** is at Johns Manville's Research and Engineering Center, Manville, N.J. Garth and Margaret have a grown family of four, ages 13 to 27. . . . **Karel Den Tex** has been at I.B.M.'s Rochester plant for three years. . . . **Willard B. Ferguson** has been named director of sales for the Instrument Division of Perkin-Elmer. . . . **Alfred Ginkel** is now a corporate officer at Sybron Corp. His title is Area Manager-Asia and he moved from Hong Kong to Rochester, N.Y. Moved to the scene? . . . **Dick Greenwalt** has moved to Oakland, Calif. He is manager of metallurgical engineering for Kaiser Engineers. He just returned from a month in Australia. . . . **Arthur W. Heineck** left I.B.M. after 12 years to join INFOREX where he is v-p engineering.

Robert Cushman was awarded a Certificate of Appreciation by the Alumni Association for his efforts on the 1970 Fund Drive, and **Charles Hieken** was awarded a Presidential Citation (M.I.T.) for his contribution to a new program of seminars for young alumni. . . . **Vernon W. Kenney** plans to spend three years in a 12-room villa on the Italian Riviera while modernizing a photo products plant for Ferrania (3M). "Land of the Lira is wild" says Vernon. . . . **Robert L. MacCallum** is director of market development for the Mining and Metals Division of Union Carbide. . . . **Ken McCoy** is at the Palo Alto, Calif. sales office of Digital Equipment. The McCoys have eight children ages 22-7!

Lieutenant Commander **Eric Robba** has retired from the Naval Reserve and is living in Mystic, Conn. Eric is employed at Electric Boat Div. of General Dynamics in Groton, Conn. . . . Volume 167 of *Science* had an article on solar effects on the frequency of 18 centimeter radiation, one of whose authors was **Hays Penfield.** . . . **Thomas A. Weil** is one of two Raytheon engineers who are contributing authors to "Radar Handbook" a new comprehensive survey of the radar field. He is the department manager of the transmitter department in the Radar Systems Laboratory at Raytheon's Wayland Facility.—**Fred W. Weitz,** Secretary, 4800 S.W. 74th St., Des Moines, Iowa 50321; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107; **John Dowds,** 1800 N.W. 18th, Oklahoma City, Okla. 73106; **Samuel Rubinovitz,** Assistant Secretary, 3 Bowser Rd., Lexington, Mass. 02173

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Summer has passed again and we of '52 can now look forward with anticipation to next summer and our 20th reunion. **Harold McAleer** has sent me the following: Plans for our fabulous 20th reunion are shaping up rapidly. At a recent meeting at Valle's in Newton, the following committee was appointed (between beers): Chairman, Mike Nacey; Treasurer, Stan Sydney; Accommodations, Sandy Isaacs; Program, Arnie Kramer; Publicity, Harold McAleer; Receptions, Russ Olive; Master of Ceremonies, John Fitch; Area Rep. Chairman, Arthur Turner; Statistics, Stan Buchin.

The reunion will be held on the weekend of June 2, 1972 at the beautiful Harborside Inn in Edgartown on Martha's Vineyard, a spot that offers everything—convenience, swimming, boating, fishing, golf, tennis, shopping, relaxing, etc. The group is planning a weekend of fun for all of you, stag or drag along the whole family. By all means plan on it and watch the mails for the exciting announcements!

Promotions among our classmates are coming rapidly. **John J. Magarian** is now president of Bowmar Canada, Ltd. . . . New manager of Koertrol Corp., subsidiary of Schutte and Koerting Co., is **Robert F. King.** Bob served on the staff of M.I.T.'s School of Industrial Management immediately after graduation. He then obtained a master's degree from the University of Delaware. Now living at 3211 Pickett Rd., Durham, N.C. Bob invites all old classmates with an interest in bass fishing to try his newly acquired five acre pond to see if their luck still holds. . . . **Allan Chin** writes that he is now in Palo Alto as vice president of International Nutronics, Inc.

E. F. Erbin is currently general manager of the Magnesium Division of National Lead Company, Salt Lake City, Utah. . . . New president and director of H. F. Livermore Corp., textile machinery manufacturer in Allston, Mass., is **Zenas Crocker.** Zenas was previously president of a plastics division of Tenneco. He notes that he is enjoying his shore house at Oyster Harbors, Cape Cod. . . . **Richard P. Haley** is now manufacturing manager of Scientific Instruments Division of Beckman Instruments, Fullerton, Calif. . . . **J. Povah Lynch** has been appointed assistant director of technology for the Anaconda Co., 25 Broadway, New York City. He was previously manager of the research and technical center of Anaconda American Brass Co. in Waterbury, Conn. . . . **Robert E. Dargie** is now manager of Systems Planning and Advanced Engineering of American Optical Company's Optical Products Division.

Lou Di Bona writes of a recent surprise addition to his family, a son Anthony Richard, now 2½. Lou also has a daughter 16 and another son 13 years old. . . . **Ed Margulies** writes that his wife, Paulette, is expecting a child due August 7, 1971. . . . A final personal note: **Leon Polinski** extends his personal greetings to George Splotzkados. (George, as you will all recall, was previously very active in the class and we expect that he will be instrumental in promoting the coming reunion.)

Jack Larks writes that he has participated in a three-week mission survey-

ing the entire island of Jamaica utilizing remote sensing techniques for an earth resources analysis. At the request of the government of Jamaica, through the United Nations, the United States sent the NASA/M.S.C. C-130 Earth Resources Survey aircraft to accomplish the mission. . . . **Richard H. Silverman** writes that he has recently returned to his consulting practice after spending seven years in management in distribution (logistics, warehousing, transportation, and materials-handling). **Frances Richey Oberheim** has just been elected Republican precinct chairman in a Washington, D.C. ward containing 17 per cent registered Republicans but many independents (government workers). She complains that Course VIII never prepared her for such a task. . . . M.I.T. recently presented an Exceptional Service Commendation in connection with the Apollo 14 mission to **Phillip G. Felleman.**

We have news that **Qazi B. Ahmed** is now an associate of the Architects Collaborative, Inc., Cambridge—**Arthur S. Turner,** Secretary, 175 Lowell St., Carlisle, Mass. 01741

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It is the middle of the summer here in Framingham Centre and I am at my library writing desk once again.

Herb Slater takes time from the building of his "castle" in Long Island to notify us of the birth of his first son, Joshua Freeman Slater. He also endorses the idea of having our twentieth class reunion in Bermuda; and has volunteered to organize reunion attendance from alumni in the New York City area.

Career Capsule news from the wire services: The Roanwell Corp. has announced the appointment of **Bob Anslow** as executive vice president. . . . **John Murkland** is presently Director of Marketing for Government Operations of the Perkin-Elmer Corp. in Wilton, Conn. . . . **Daniel F. Tully** is president of Daniel F. Tully Associates, Inc., an architectural engineering firm in the field of shell construction. . . . **Larry Leonard** is Senior Staff Metallurgist at the Franklin Institute in Philadelphia. . . . **Emil L. Krejci, Jr.** is president of a new venture in plastics consulting and development. . . . **W. J. Kocher** has been appointed General Manager—International for Welding Products Division of the Air Reduction Co.

Fellow alumni classmates receiving recent honors: **Paul E. Gray,** Dean of the School of Engineering at the Institute elected to the American Academy of Arts and Sciences. . . . **Paul D. Spreiregen** made an Honorary Fellow of the American Institute of Designers. . . . **Everett A. Glendening** received two First Honor Awards for design from the American Institute of Architects. . . . **George R. Voss** received the M.B.A. degree from the University of Akron.

How about taking a minute now and writing your secretary with the news of your family, career and summer activities and with your vote, yea or nay, on our projected twentieth reunion site: Bermuda.—**Harvey Steinberg,** 273 Singletary Lane, Framingham Centre, Mass. 01701

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Another fall is upon us. I hope that you had a pleasant summer, and that your furnace is in good shape. My property tax is so high that I have sent my children to live in the school. At John Carroll University, Very Reverend **William H. Nichols,** S.J., has been appointed rector of the Jesuit Community. In this role, Father Nichols is president of the John Carroll Jesuit Community Corporation, and religious superior of the 50 Jesuits residing at Carroll. Father Nichols, an associate professor of physics, has been a member of the J.C.U. faculty since 1967. He also serves as a member of the board of trustees.

Recent graduates of the State University at Rutgers, N.J., are **W. Lewis Brillhart,** who received the M.S. degree, and Joseph G. McNeill, who received the Ed.D. degree. . . . In May, **William D. Chandler** completed the M.B.A. program at the University of San Francisco, receiving the "Master Administrator" award as the school's outstanding M.B.A. graduate in 1971. . . . **Peter Brand** completed his internship at Maine Medical Center in June. . . . **David A. Brown** is now the head of the mathematics department of the Rockland Country Day School at Congers, N.Y. . . . **Harold R. Austin, Jr.,** is Head of the Physics Department at Wentworth Institute, Boston, Mass. . . . **Daniel M. Braddock, Jr.,** is currently living in Poughkeepsie, N.Y. with wife Joanne and their five children. He has been with I.B.M. for eight years, and he is now the manager of a simulator development group working on system performance analysis simulators.

During the Apollo 14 flight, trouble on the lunar module nearly ended the descent to the moon's surface. A group of engineers working at the Draper Laboratory at M.I.T. devised an alternate procedure, permitting a successful landing. Among the 16 engineers who received Exceptional Service Commendations for their part in saving the mission was **Larry Berman.** When he's not running, he's rescuing. . . . **Donald G. Brennan,** who is a member of the Hudson Institute and edits the journal *Arms Control and National Security,* wrote two provocative articles for the *New York Times* last May. He brought into question the "mutual assured destruction" posture of our strategic nuclear policy, and suggested that a strategic alternative would be to look for incremental changes in the ratio of defensive to offensive systems. Given any means of reducing the offensive threat, such as negotiations, the effectiveness of defense can be increased, in his opinion. Consequently, he suggests that our strategic offensive and defensive forces approximately match those of the Soviets, following his "Brass Rule," by which we can do them in about as much as they can do us in. In effect, he urges a greater emphasis on providing increased defense.

This summer your secretary has divested himself of the job of Editor of the I.E.E.E. Transactions on Antennas and Propagation, a three year sentence that made him the personal symbol of evil and incompetence to aspiring authors in this technical area—mothers and babies, authors and papers. However, an editorial career is hard to resist. Having won election to the I.E.E.E. Boston Section Executive Committee, I am now editor of their local magazine, and shall write flaming editorials about technical lecture series while engineering employment disappears. If you would like a line or two of recognition of your activities, please send the news to—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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Friday, June 4, dawned bright and clear following a cold, wet and dreary spring in New England. Arriving at the steamship dock in Woods Hole at 1:30 we found a dozen classmates already in line—plus another ten who parked and hitched rides. (The crush became so great on Saturday the steamship authority put on extra boats.) In all, 73 classmates plus wives, girlfriends, and etc.? appeared for all or part of the next three gorgeous, warm, cloudless days (so the three sober ones tell us). Anyway, the nine-mile drive from Vineyard Haven to the Harbor View on the north side of Edgartown Harbor took 12 minutes by the shortcut. (We smelled the beer.)

Poolside was the gathering point for all activities and remained well occupied for the weekend, in part, due to the presence of a few beer kegs. Bicycle riding around the quaint whaling village and those giftshops was the highlight of the reunion according to the bill the Class paid to the rental agency (working off those 8.33462 pounds gained since graduation). . . . **Bill Grinker** had arrived the night before to personally ensure that room assignments were properly ancient, modern, remote or full of moth balls to fit the classmate. The Inn's staff of bright, young collegiates proved that youth can run faster and they still gave us excellent service. All registrants had their mug shots taken by Diane and **Ted Korelitz** with Polaroid's latest, the Big Shot, later given back as a memento when more compromising substitutes were available. Unstructured happenings were the feature of the weekend and everyone enjoyed it. To give us an interface with Tech today, Professors David Baltimore, Dean Richard Sorenson and U.A. President Gregory Chisholm spent Saturday with the Class. The summation of these conversations was presented at dinner. Following that, awards were presented for outstanding activities of the weekend—for example, Guy and Lee Spencer for hunting deer out of season with the grill of their car and then hitchhiking to the reunion.

Sunday morning, Nomination Committee Chairman **Sven Vaule** presented the proposed slate of class officers and received approval: President, Bill Grinker; Vice President, Lloyd Beckett, Walt Frey and Guy Spencer; Cosecretaries, Bruce Bredehoft and Margie Gilson; Treasurer, Lloyd Brace.

Other features included Judy and **Ron Clark** arriving at the reunion on their cabin cruiser, which served as the com-

G. Snyder, '59

M. Ain, '64

modore boat for the fiercely competitive Sunfish Regatta. The sailboat trophy was awarded to **Rusty Schweickart** and **George Baker** who demonstrated the advantages of combining astronautical training with sailing experience in quickly righting an overturned boat to win. George was in training for the Trans-pac sailboat race to Hawaii. His real estate interests take him all around the West Coast area. . . . One of the two coeds at the reunion was **Virginia Coburn Clarke,** who has owned and directed a successful nursery school for the past 11 years. Her husband, Bob, is a building contractor who enjoys finishing kit or damaged boats.

One of the other sports enjoyed during the weekend was golf. The prize for 18 holes went to Dianne and **Tom Hoffman.** They have been living in Narrows, Va., where he has been with Celanese. In their seven years there, they have brought some theater arts to that corner of Appalachia by founding a little theater group. Dianne owns and runs a dance studio and has taught Tom enough for them to be frequent entries in state jazz and ballroom competitions. Sandwiched in between these activities have been three children.

Our happy group feasted on the traditional Sunday lunch of steamers and boiled lobster before swarming back aboard the steamship to the mainland.

By the way, did you miss feeding the gulls on the wing from the top deck? More on the details next month, but meanwhile thanks again to **Ron Massa's** prodigious telephone effort last spring to bring together such a large gathering at a memorable 15th. Remember, send in your $8. dues and receive your copy of the questionnaire results in which Phil Bryden analyzed over 200 classmate responses.—Cosecretaries: **Bruce B. Bredehoft,** 3 Knollwood Dr., Dover, Mass. 02030; **Mrs. Lloyd Gilson,** 35 Partridge Rd., Lexington, Mass. 02173

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And away we go with another volume of *Technology Review.* . . . First a note from **Arthur Cowen**: "I received my M.S. in chemical engineering from N.Y.U. in 1960 and my M.B.A. in finance from Columbia in 1964. After working for Air Reduction from 1964 to 1966 in commercial research, I joined Shearson Hammill (277 Park Ave., New York) as a stockbroker. Does somebody need a good broker?" . . . **Ron Delaney** wrote us that he is now vice president and chief engineer for Alloys Unlimited, a division of Plessey. Ron is married and has three boys and one girl. After leaving Tech, Ron served two years in The Chemical Corps and received the Department of Army award at Dugway Proving Ground. This was followed by eight years with I.B.M., during which time he received IEEE's William G. Teeller Award and I.B.M.'s Achievement Award (five patents). . . . **Gerald Levine** is now sales manager for Denis McCauley and Co. Investment Securities in Minneapolis, specializing in over-the-counter regional securities.

Nelson Hsu is still with American Cyanamid at Stamford, Conn. His note added that he received his M.B.A. in 1970 from the University of Connecticut and has been recently initiated into The Beta Gamma Sigma scholastic honorary society. . . . Carol and **John Marsland,** who earlier were in England, are enjoying their return to the States. Their fourth child and second son was born in late April. They report having had a fine visit recently with **George Seiler** who is also in the plastics game—George with Stauffer; John with Uniroyal. . . . **Peter Schwarzkopf,** who is now vice president of Isopressed Products Corporation of Canoga Park, Calif., recently coauthored an article in *Metal Progress* on the subject of Isostatic Pressing. . . . **Jay Bonnar** has been promoted by Handy and Harman to Manager of their Powders and Arts Division. . . . And finally, **Martin Zombeck** advises us that he is a project scientist for the V-Ray Telescope to be flown on Skylab I in 1973. Martin received his Ph.D. in physics from Tech in 1969.

That's all the news for now. Since our reunion (number 15) is but a few months away, I'll be devoting increasing space to arrangements and notes on who's planning to come. Betty and I have already scheduled our home leave to coincide with reunion weekend and hope to see a big turnout.—**Frederick L. Morefield,** Secretary, Tiirasaarentie 17, Lauttasaari, 00200 Helsinki 20, Finland

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Welcome to Volume 74 of *Technology Review.* This column is being written on the beach at Mission Bay, San Diego where I'm enjoying a well-earned (it says here) vacation. . . . **Phil Houghton** writes that he is involved in advertising with Robert Hall Clothes and for hobbies he dabbles in photography and sculpture. Phil is living with his wife and two children, Timothy (12) and Amanda (4) in New York. . . . **Hector MacKay** is a vice president with Duraform, Inc., an injection molding and structural foam molding concern which uses the Union Carbide process. He spends his spare time in water sports and organizations such as Rotary, S.P.I., S.P.E. and S.M.E. Hector lives with his wife Elaine and son Bob in San Juan, P.R. . . . **Mike Garnier** is currently with I.B.M. in San Jose. He enjoys gardening and deep-sea fishing. He and wife Rose have four mellifluously named offspring—Melinda (7), Mike (5), Michelle (3) and Mark (1). . . . **Jim Miller** writes that he is an attorney with Gelfand, Greer, Popko, Nicholoff and Miller, a legal corporation. Jim is also the San Diego County Democratic Central Committee Chairman. He relates that he left the engineering profession just prior to the recent slump and credits luck, not brilliant planning for this move. Jim and his wife Nancy have five children—Lauri (11), Chris (10), Eric (9), Julie (8), and Janet (4). . . . **Ron Colier** is product manager for Xerox Data Systems in Los Angeles and affianced to Theresa Olson. In his free time Ron lectures and teaches transcendental meditation to members of the business and professional community under the auspices of the American Meditation Society. Ron recommends trying it to increase intellectual capacity and gain deeper relaxation at the same time. . . . **Merrill Ginsburg** is now an associate geophysicist at the Exploration Services Center of the Mobil Oil Corp. in Dallas, Texas. . . . **Cliff Yamada** has recently moved within the Defense Communications Agency to Stuttgart, Germany from Wheeler A.F.B. in Hawaii. Cliff and his wife Helen also have five children—David (9), James (7), Michael (6), Edward (3) and Joan (6 months).

I received notification that **Fred Bielawa** and his wife Patricia participated in the 23rd M.I.T. Fiesta held by the M.I.T. Club of Mexico. . . . **Leon Bledjian** informs me that he is currently employed by the Western Division of the McDonnell Doug-

las Corp. and lives with his wife Victoria in Huntington Beach, Calif. . . . **Al Girotti** writes that since 1968 he has been on the faculty of the Department of Biochemistry at the Marquette School of Medicine in Milwaukee, Wisc.

Dix Browder writes that he is currently production manager in the microelectronics department of Hewlett Packard's Microwave Division in Palo Alto, Calif., and that his first child, a daughter Carrie Beth, was born last January. . . . **Ed Hooper** has moved to the San Francisco area and is working in the Controlled Nuclear Fusion Program at the Lawrence Radiation Laboratory in Livermore. . . . **Larry Broutman** recently became co-recipient of a patent for transparent armor developed under an army contract at the I.I.T. Research Institute in Chicago. The material is intended to protect things men look through—windows, windshields, combat goggles—from such hazards as shrapnel and grenade bursts. . . . In a press release from Dravo Corp., it was announced that **George Snyder** has been appointed manager of the technical analysis section in the research and development department of this Pittsburgh company. . . . **Dave Garelick** is presently Associate Professor of Physics at Northeastern University. . . . **Adrian Reti** recently joined Millipore Corp. as director of Latin American marketing. He is still living in Cambridge and like yours truly, is enjoying the life of a bachelor while it lasts. I still have a bit of news left but the water looks very inviting and I'll need some news for next month—so, I'll see you then.—**Arthur J. Collias,** 61 Highland Rd., Brookline, Mass. 02146

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Happy fall to one and all.

Moving Ahead—**David M. Schroedl** was recently elected the vice president of finance and administration for the Jack A. Benaroya Co. (who are the designers and builders of office buildings, industrial and business parks in the Pacific Northwest). . . . **Thomas F. Morgenstern,** along with his partner, has opened a second office for the practice of Orthodontics. His first office is located in Hightstown, N.J., his new office is near Freehold, N.J. . . . **Alan L. Loss,** a vice president at the New York Stock Exchange's Electronic Systems Center, was recently appointed to head their new department of operations. This department is one of three that will replace eight former units.

Busy People—In August, **Martin Klein,** of Salem, N.H., president of Klein Associates, presented a featured technical paper at the annual meeting of the Marine Technology Society in Washington, D.C. In his presentation he discussed experiments supported by the Academy of Applied Sciences of Belmont, Mass. He explained how from a "Sonar Search at Loch Ness, Scotland," among other things, large undercuts in the loch's sloping bottom were found—large enough to provide a hiding place for an "elusive monster." . . . When **Harry McCraw** finishes with his copies of *Technology Review,* he passes them on to the science library at the University of Southern Mississippi, where he is employed. He has been told they are a big hit. . . . **Michael R. Terry** recently ran for class alumni representative to a corporation from the class of 1969. Unfortunately he lost. . . . Marco A. Murray was one of the national attendants at the Twenty-Third Annual M.I.T. Fiesta in Mexico last March.

Keeping in Touch—Dr. **Norman D. Strahm** is presently an Assistant Professor in the Department of Physics at the Chicago Circle Campus of the University of Illinois. . . . After working for three and one-half years at DuPont, and teaching Chemistry and English at the Catholic University of America in Washington, D.C. for one year, **Herschel Clopper** is now employed at Polaroid in the Applied Technology Division. He says it feels good to be back in New England, particularly the Boston area. . . . Since July of 1967 Dr. **Thane Smith** has been employed at A.I.L., a division of Cutler Hammer, as a Research Scientist; in June 1968, he received his Ph.D. in Physics from Carnegie-Mellon University.—**Gerald L. Katell,** Secretary, 122 North Maple Dr., Beverly Hills, Calif. 90210

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The summer publication break has produced no less than a half dozen Class Heroes (defined as any classmate who writes the news-starved class secretary a personal letter). Class Hero **Richard Adamec** writes that he has married this past July to the former Miss Oashia Ablamsky. Richard is a transportation marketing consultant with Dun and Bradstreet. . . . He notes that **Dave Dunford,** a foreign service officer currently stationed in Helsinki, Finland, was in the U.S. on a month's leave in August. Dave and his wife Sandi have a 18-month-old son and have adopted a ten-month-old Finnish girl. . . . Class Hero **Pete Angevine** and his wife Rosalind are living in Ridgefield, Conn. with their six-month-old daughter Sharon Jean. Pete is now in his seventh year with Dorr-Oliver, a chemical process equipment firm based in Stamford, Conn. He and Rosalind met in India while Pete was working on a project over there.

Class Hero **George Harlem** writes that he is product line manager for teleprinter communication terminals with Syner-Data, Inc. in Beverly, Mass. He, his wife Rosina, and their two and one-half year old daughter Jenifer are living in Acton, Mass. George reports that **Ernest Henrichon** and **Robert Sanders** are working for Infoton, Inc. in Burlington, Mass., George's former employer. He informs us also that **Richard Carpenter** (our Class President) is with Index Systems in Cambridge. . . . **Dave Morrison** joins the Class Hero ranks by reporting his contact with other classmates. As chairman of the Albany-Troy Alumni Fund for M.I.T., he has talked to **Lance Bosart,** who is a professor at New York State University in Albany. . . . Dave was visited this past spring by **Steve Schlosser** and his wife Marlene, who were concluding a vacation in the Catskills. Dave is employed by General Electric and lives in West Sand Lake, N.Y.

Class Hero **Leonard Theran** and his wife Susan have left their home in Scottsdale, Ariz. for a six month vacation tour of Europe, Israel, and points east. . . . **Phil Townsend** is a Class Hero who is currently in the Harvard Business School doctoral program. He plans to teach and consult in the area of operations management, with emphasis on the chemical industry. Phil and his wife Sandy are living in Lexington with their two daughters, where he reports that they are on the front lines of the war on international crabgrass, taxes, and the P.T.A. (Sandy is a school teacher). . . . Class Hero **Bob Wisleder** received his M.B.A. from Northeastern University this past June. He is now a project engineer for the U.S. Department of Transportation in Cambridge, where he is developing experimental navigation equipment for S.T.O.L. aircraft. Bob and his wife Janie have three girls, the youngest of which was born at 12:02 a.m. of Christmas Day in 1967, the first birth that day in Boston.

That concludes the list of Class Heroes. The rest of you out there in reader land are cordially invited to achieve similar fame and fortune inherent in being published as a Class Hero. All it takes is an eight cent stamp and a scribble to your secretary.

On a more somber note, the Alumni Fund reports the death of classmate **Dan Frischmuth** on March 15, 1971. No details were given. . . . As for news of others, the following were in attendance at the M.I.T. Alumni Homecoming in June: Leslie (Bud) Boring, Richard Cease, Ernest Henrichon, Lawrence Kaldeck, Eddie Shibata, and Fred Silverstein.

Mark Ain has joined the management consulting firm of Billings and Reece, Inc. of Concord, Mass. as an associate. . . . **Patricia Crowther** received part of the Rumford Award for astronomical interferometry work at Lincoln Lab's Haystack facility. She has left the work force for a few years to raise her two children, Sandy and Laura. . . . **Victor Liang** received his Ph.D. in physics from Cal Tech this past June. . . . **Neil Pappalardo** is a vice president of Meditech, a firm providing computer technology to the medical field.

Martin Poe has authored an article in the DuPont *Innovation* magazine concerning proton studies of proteins. . . . **Larry Rabiner** is working on the development of computer spoken synthetic speech for Bell Labs. . . . **Donald Stewart** is living in Reston, Va. with his wife Elizabeth and their two children. He is the regional sales representative for Teradyne, Inc. . . . **Janet Stober Van Blerkom** received her Ph.D. in physics last June from the University of Colorado.

As for news from yours truly, my wife Betsy (B.U. '67) and I are happy to report the birth of our second daughter, Sherry on July 19, 1971. Have you noticed the overwhelming prevalence of daughters in this column? Someone should write a thesis on the effect of four years at M.I.T. on the dominance of the Y chromosome! Let me hear from you.—**Ron Gilman,** Secretary. 5209 Peg Lane, Memphis, Tenn. 38117

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In early June, I received news of the near escape of **Bill Alves** during a climbing trip in the Sierras. Bill was one of a party of five trying to ascend 13,157-foot Mt. Ritter. As the party approached the summit, a late May blizzard trapped them with winds of 70 to 80 miles an hour, snow, and cold. During the storm, one after another of the party froze to death until, on the following day, Bill was the only survivor. He hiked more than twenty miles to a highway during the four days following the storm and hitched a ride to a ranger station. Bill was suffering from frostbite on three fingers but plans to return to Mt. Ritter over the Labor Day weekend and try the ascent again. The *Palo Alto Times* quotes him as saying "I'm not out to match the mountain or conquer it, but it's a beautiful mountain and I'd like to go back." Bill's story was reported by **John Murray,** among others. John is now with the army at Redstone Arsenal, Alabama and sent in a clipping from the *Huntsville Times.*

By now many of you have probably heard of the election of **Jim Hester** to the M.I.T. Corporation in the young alumni category. Jim received his Ph.D. from Tech last year and is now a senior quantitative analyst with New York City's Housing and Development Administration. . . . Also in the news is **Fred Gander** who has been named director of economic research for the Associated Industries of Massachusetts. Fred holds a master's in business administration from the Wharton School of Finance and Business and was formerly with Inland Steel Co. Fred and his wife, Carol Anne, live in Wellesley and have one daughter. . . . This has been a month for letters as well as news. **Chico Gholz** says he was galvanized into action by the pathetic appeal for news in May's column. He is now entering the second year of his clerkship at the Court of Customs and Patent Appeals and working on a master's in patent law at George Washington University Law School. The Gholz's report the birth of their first child, Charles Eugene, on February 10. . . . **Bill Samuels,** also sent a letter with a reference to my pleadings for news (well, they worked.) After serving in the army, Bill worked in his father's gubernatorial campaign through June, 1970. Then he served as director of Adam Walinsky's campaign for Attorney General of New York. Bill says his M.I.T. experience served him well during this period as a full-time politician. Now, however, he has retired from politics and is vice-president of a company called MIND, Inc. MIND produces audio-visual educational systems for the disadvantaged adult and is involved with the social problems faced by both industry and government. Bill has also been playing the role of a venture capitalist on the side—most recently with a laundromat business in Japan. He also keeps busy with political activities and helped raise the money that supported the Vietnam Veterans march in Washington.

Jim Taylor has been transferred to Houston, Texas by Humble Oil and Refining Co. Jim is coordinator of professional recruitment for Humble with responsibility for college recruiting in the central part of the country. Jim and Gladys now have a son Jeffrey Wayne (February 17, 1971) to go along with their daughter Kimberly Elizabeth. They are both enjoying watching the young ones grow and learn. The new Taylor residence is just to the north of the Houston airport (or just to the south of Dallas).

Ed Yourdon and his wife Pat and daughter Jennifer are living in Brooklyn. Ed is working on an M.S. in electrical engineering at Brooklyn Polytechnic Institute and lecturing and consulting on the side. Ed's second book, *Design of On Line Computer Systems,* will be published in the spring. Ed was also author of an article "Maybe the Computers Can Save Us After All" in last May's *Computers and Automation.* . . . Judith and **Pierre Perrolle** are about to relocate to Hong Kong after a year in Taiwan. Pierre is finishing his Ph.D. research and Judith has been senior systems engineer for a Chinese computer company. The Perrolle's have enjoyed Taiwan (especially their daughter Jeanette who is now fluent in Chinese) but will be glad to get back to the U.S. and some political activity. . . . **Mark Stein** reports he is a Radiology Resident at U.C.L.A. and a potential unfortunate for the doctor draft now underway. . . . **Vinod Jhunjhunwala** is continuing to manage a strawboard plant in India and is actively pursuing a scheme for the manufacture of paper. Vinod's daughter Ranjini was three years old last May. . . . **Ed Miller** has received his Ph.D. in economics from M.I.T. He is now working in the Office of the Secretary of Transportation in Washington. . . . **Po Chiu Mar** moved out of New York City in July, 1970 and joined the ranks of the commuters—one and one-half hours each way. Po does not recommend such lunacy for anyone. The Mars' second child—a daughter Pamela—was born March 31, 1969.

Our Class continues down the educational road with some people finishing degrees and more getting close. **Bill Grosky** finished a Ph.D. in engineering and applied science at Yale this summer and has accepted a position as Assistant Professor of Information and Computer Science at Georgia Institute of Technology in Atlanta. . . . **Barry Wessler** is working on a Ph.D. at the University of Utah. He is also consulting for the Board of Governors of the Federal Reserve System helping to plan a new data communications system. . . . **Frank Gerstle** hopes to finish his Ph.D. soon and locate a company or school that needs a "young, balding, ambitious, hard-working mechanical materials engineer who is only slightly overtrained." Frank also reports the birth of a son last April 13. . . . **Richard Sherman** received a Ph.D. in theoretical solid state physics from Cal Tech and is now searching for a job. . . . **Art Sindoris** completed his Ph.D. in electrical engineering at New York University this summer and is now in applied research at Harry Diamond Laboratories in Washington. . . . **Mark Strovink** received his Ph.D. in physics from Princeton in April 1970. He is now Assistant Professor of Physics at Princeton on leave at the National Accelerator Laboratory. Mark and his wife Joyce have a one year old son, Kurt. . . . **Peter Klock** hopes to finish his Ph.D. in biophysics during the 1971-72 academic year. His dissertation concerns tertiary structural changes accompanying state transitions in "lamprey" hemoglobins. . . . **Dave Hall** received a Ph.D. in physics from Cal Tech last June. . . . **Greg Johnson** is working on his Ph.D. in physics at the University of Rochester. . . . **Allen Pogeler** received his M.B.A. from the Harvard Business School last June.

At Tech Night at the Pops last June I encountered **Steve Dangel.** Steve is now with Polaroid in Cambridge. He was formerly chief engineer with Lawson Hemphill in Rhode Island. . . . **Jim Pepe** is now with Intermetrics, also in Cambridge. . . . Also among the staff at Intermetrics is **Woody Vandever.** . . . Finally, **Ralph Cicerone** reports he "just returned from a backpacking trip in northern Maine." Your secretary did likewise and the only sad part was the return to civilization.—**Steve Lipner,** Secretary, 3703 Stearns Hill Rd., Waltham, Mass. 02154

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Class reunion has come and gone, and in the shuffle we acquired new class officers. **Terry Vander Werff** deserves an immense amount of credit for the job he's done over the past two years so we will retire the "Hero of the Month" award to him!

In looking over the mail for this month, it is good to see that there are still members of our class working on degrees. **Lee Casperson, Howard Nicholson,** and **Steve Kurtin** all received their Ph.D.'s from Caltech this June. **Charles Boley** received his Ph.D. in physics from M.I.T. in February and now teaches at the University of Toronto. **David Hayes** also entered those fortunate ranks when he received his doctoral degree in chemistry at Cornell this past June. He is doing post-doctoral work at University of Rochester.

Jim Funderburg and **Jim Veazey** have completed medical school and have begun to reap the "benefits." Dr. Funderburg has begun an army residency in ear, nose, and throat surgery with a year of pre-specialty training at Fort Campbell, Ky. Jim Veazey is interning at Mary Hitchcock Hospital in White River Junction, Vt. We'll wave as we drive to Sugarbush, Jim!

On the other side of the fence we have those who are still working on degrees. **David Enfield** is finishing up his Ph.D. at Boston University. . . . **Bill Moss** is working on his at University of Delaware. Bill has the unenviable task of completing a Ph.D. in mathematics. . . . At Stanford **Carson Eoyang** is making progress at Stanford's B-School. He says "except for campus unrest, police reactions, winning the Rose Bowl, Ronald Reagan, California sunshine, and earthquakes, it's just like the good old days!" Which good old days were those, Carson? . . . **Jim Carroll** is also winding up at Stanford and is finished except "for the dogwork part." . . . There are also rumors that

Ralph Schmitt, Phil Bendick, Jurgen Hahn, and **Franz Birkner** are alive and well in various parts of California.

Terry sent on several letters that arrived after the change of guard in June. Some of them are rather long and will provide fuel for the lean months this winter. One came from **Steven Levin** now living in southern Tennessee. His letter is very intriguing as it relates his life with 350 other people in a community called The Farm. "Though it's called The Farm, we are a community and need many things built. Consequently, I am into both farming and engineering (lowering water towers and constructing canning equipment). The combination of the two is good for the soul . . . living here is just living and is not segmented into job, home life, weekend or vacation." Steven sends his address for those wishing to write. . . . Here in Boston **Mike Kinkead** writes that he and his wife Marilyn now live on the Boston waterfront in a converted warehouse and really like it. Mike currently serves as vice president and director of National Information Services in Cambridge. . . . **Ken Browning** is now Assistant Dean for Student Affairs with primary responsibility in the residence program. Is it possible we have a "Dean Fassett" in our class? . . . **Ed Graham** is working as research associate at Harvard Business School where he recently published an article in the *HBS Bulletin*. . . . In nearby Danvers, the Reverend **Paul Aita** is serving as Pastor of the First Baptist Church. . . . Judy and **Matt Fichtenbaum** are now living in Chelmsford. Evidently Matt has decided country living is worth the commute. . . . **Paul Rudovsky** is working for First National City Bank in New York where he is an assistant vice president. He reports that **Larry Calof** is a lawyer in L.A. . . . **Jeff Trimmer** has been promoted to a new position in product planning working on the 1974 Mustang. . . . **Hank Perritt** is a senior sales planner at Lockheed-Georgia and is active in Republican politics. That's funny, I always thought Hank was a Democrat! In any event, Hank says that he is "still single and working hard to stay that way." . . . That's it for this month. I will be running behind for a few issues but I'll give special attention to the first five letters I receive as Secretary!—**Tom Jones,** Apartment 35, 33 Commercial Wharf, Boston, Mass. 02114

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During the past summer I have been able once again to take advantage of my technical background. I have been driving a beer truck in North Dakota—no complaints. My body needed some calluses, and I met a lot of good, friendly, and weird people in the bars of rural North Dakota. Since I will soon be pushing my VW bug towards Stanford and another year of law and business, I had better finish this month's notes now when I have the chance. Here's the latest.

William Christiansen happily writes that he is now a civilian, having spent two years in the army at the invitation of Uncle Sam. His duty was not too bad, however, as he was stationed about 40 miles from Venice. Bill received his master's from the Sloan School in 1969 and at the same time was active with Equipment Company of America of Florida, a materials handling manufacturer. He is now living in Florida and giving full attention to his duties as executive vice-president. The company went public in May, 1971. . . . **Allen Gammon** is returning to graduate school at University of Illinois this fall. . . . **John Podolsky** is a freelance flight instructor in addition to being in systems programming at Xerox Data Systems and in graduate school at U.C.L.A. . . . **Bill Wilber** writes: "I have just finished my second year of graduate school at University of Wisconsin, after working two years in industry. My wife Diane is from Maine, and we have a son who will soon be three. Strangely, the annual spring riots did not materialize this year in Madison. Does anyone have a job for a Ph.D. chemist?"

Dave Schramm won the National Greco-Roman Wrestling Championship in the 220 pounds weight class. The tournament was held in Las Vegas in May, 1971. . . . Ellen and **John Robinson** have their first child, John Charles, born November 6, 1970. The Robinsons and Barbara and **Bruce Williams** attended the wedding of **Don Bellenger** and Cathy Litwin in Washington, D.C., in June. . . . **S. Vichitranonda** is chief architect for Bangkok Bank Ltd., Bangkok, Thailand. . . . **Tom Hughes** is finishing up his tour with a 19 month stint in the Philippines. . . . **David Ofsevit** graduated with an S.B.-S.M. in 1969 and worked for M.I.T. a year until the funds gave out. He managed to I-Y his way out of the draft and is now with the Department of Transportation in Cambridge. He is still single. . . . **Richard Beger** is expecting to complete his Ph.D. requirements in geology at Harvard. He is considering a job offer at the Manned Spacecraft Center in Houston. . . . **Paul Goldstein** graduated from Washington University Medical School and is serving an internship in pediatrics at St. Louis Children's Hospital. In January he married Eileen Rubenstein of Skokie, Ill., and they spent a few months in Europe. . . . **Robert Mitchell** is serving in the Air Force. . . . **Bob Bruneau** has made good his exit from our "modern action army" and has returned to Penn State to complete work on his doctorate in mineral economics. His thesis will probably involve simulation of mineral exploration. Concurrently, he is working in systems planning for the Penn State Management Information System. His wife Lynn is planning to embark on a master's program in either geology or geophysics at Penn State.

Richard Chappell has been attending graduate school at University of South Carolina in physics. He has been making his living by playing with the rock band "Fire and Rain", and he will continue to do so until the job situation improves. . . . **Joel Speare** has been working at Aerospace Corporation in El Segundo, Calif., since July, 1968. He has a son, Geoffrey, age two. . . . Mark Magnussen is officer-in-charge of SM-1 Nuclear Power Plant at Ft. Belvoir, Va. . . . **Robert Hall** is Associate Professor of Economics at M.I.T. . . . **Ray Ferrara** has been serving in the Peace Corps in the West Indies. . . . **Robert Dann** received a licence es lettres from University of Montpellier, France, in 1969. He married Rosemary Weinstein of Millis, Mass., in June, 1970, at the M.I.T. Chapel. He is now serving his country as a C.O., working at Children's Hospital in Boston. Next year he will return to N.Y.U. to finish a Ph.D. in comparative literature.

After working last year on plans for the rehabilitation of several dozen houses in Washington, D.C., **Norman Wagoner** is still living in the city, teaching school, and seriously studying yoga. . . . **Michael Wandzilak** is serving in the air force in Cheyenne, Wyo. . . . **Lloyd Partridge** has completed his second year in a Ph.D. program in physiology and biophysics at University of Washington. He has two daughters, Erika and Daniella. . . . **Jeff Shapiro** had a paper published in the Journal of the Optical Society of America. He and his wife have been expecting a child. . . . **Richard Koehler** has a son, Richard Thomas, born in June, 1970.

Frank March has been working at Ocean Systems, Inc., on an oil containment system that can effectively contain spilled oil on the high seas. He described the project at the 1971 Conference on Prevention and Control of Oil Spills. . . . **Markus Zahn** has had a good year at University of Florida. He received an N.S.F. grant for research and a Sigma Tau-Tau Beta Pi award for excellence in undergraduate engineering teaching. He was drafted May 19, and the situation looks hopeless even though the induction date was postponed. . . . **Howard Greenbaum** is working at Raytheon and getting his M.B.A. at B.U. at night. . . . **Jack Mumford** married Lois Merkel of South Dakota in May, 1971. They both work for Ford. Although Ford has been a good employer, Jack regrets that the company is not located in Boston. . . . **James Moorer** is still working at Stanford Artificial Intelligence Laboratory; he has passed all his doctoral qualifying exams in computer science. He is living in a commune and is not too worried about his I-A classification. . . . I received an application for a Color Personality Report, a confidential personality description that depends upon color preferences. **Steve Marshall** is president of the company that produces the reports.

Mark Goldman will intern in medicine at Massachusetts General Hospital. He is a fourth year student at Harvard Medical School. . . . **Paul Caragine** has received a doctor of medicine degree from the College of Medicine and Dentistry of New Jersey at Newark. . . . Mrs. **Barbara Gilchrest** will intern in medicine at Boston City Hospital. She received the Richard C. Cabot Prize from Harvard for her paper entitled "A Computer Teaching Program in Hemostasis." . . . **Edward Richman** received a doctor of medicine degree from Washington University. He has begun a pediatrics internship at Cincinnati General Hospital. . . . **George Feldman** will intern in surgery at the Peter Bent Brigham Hospital. He is a fourth year student at the Harvard Medical School. . . . Miss **Janine Knauf** received an M.B.A. from Rutgers. . . . **Art**

Warshaw and **Andrew Engendorf** received M.B.A.'s with distinction from Harvard. They placed in the top 14 per cent of their class. . . . **Roger Grosso** received his M.S.E.E. from University of Vermont. . . . **George Eadon** received his Ph.D. in chemistry from Stanford University. He has accepted a position as Assistant Professor, Department of Chemistry, State University of New York at Albany.

Tom Sharon writes that he finally made it. He received his Ph.D. from Cal Tech in May. He is now working for Electromagnetic Sciences, Inc. in Atlanta. . . . **Edward Lamon** received his M.D. from Hahnemann Medical College and has begun a straight pediatric internship at New York Medical College. . . . **David Gorenstein** received a Ph.D. in chemistry from Harvard and has been teaching at University of Illinois for the past two years.—**Jim Swanson,** 1816 First Ave. North, Grand Forks, North Dakota. 58201

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By some happy circumstance, we welcome the new year with a surfeit of news. In fact, I had to hold a few items for next month. If you haven't written recently, however, please don't use this as an excuse; from our experience, the long winter ahead will bring some leaner months. Since I am currently a lady of leisure, I have the happy task of sorting through all the material. From the notes we have, it looks like the Class had a busy summer.

Weddings

Wedding bells were ringing all summer, it seems. Heading the list is **Michael Markow,** who married the former Mary Ellen Erhard of Dedham on May 16. Michael is in the Civil Engineer Corps, U.S. Navy, stationed at Brunswick, Maine. . . . **Ray Paret,** who was married June 6, reports that his record production and studio are moving along well. He is also getting involved with Intermedia Systems Corp., for which M.I.T. alumnus Stu Vidockler is treasurer. . . . In July, **Scott Mermel,** who is working for a small consulting firm in Cambridge, married the former Eve Bockner (sister of Barry Bockner '70). . . . On July 31, **Allen Currano** married Barbara Ann Orchard. Allen is working in the Computer Systems Group at the Applied Physics Lab., Johns Hopkins University, finishing his master's work (in absentia) with Berkeley, where he met Barbara. Barbara just received a master's in deaf education from Smith, and is teaching in Montgomery County, Md., where they live.

Finally, we have news that **Dave Seldin** married the former Fran Newman on August 12. After spending 15 months as a research assistant, Dave decided physics was not for him. Therefore, he got his M.S. from Colorado, and spent the next year at an actuarial job with an insurance company in New York, during which time, he met Fran. He is now at N.Y.U. Medical School, apparently with a number of other ex-physicists and engineers. Dave also reports that **Dick Fox** was in France this summer installing a computer system for Westinghouse. They had already sent him on several short trips to Europe and South Africa.

We have also received some belated news of several marriages. **Walter Eldredge** was married to Mai Fran Calhoun of Baton Rouge last August. Walter is working for Humble Oil at the Baton Rouge Refinery making aviation gasoline components. He reports "no kids, two dogs." He also says that he is active with scouts, is a member of the Baton Rouge Police Reserve, and is still dodging the draft. . . . Also last August, **Donald Fye** married Kaia Ann Valge. He is still a graduate student at Brown in Electrical Science.

Finally, we learned that **Rich Adelstein** married Sandy Culver, Smith '68, last October 17. This past year, he worked as a political science and physics teacher at Walpole and Norfolk State Prisons, and is now attending Penn Law School in a J.D.-Ph.D. program in criminal justice.

Births

Timothy Johnson reports the birth of a son, Grant Pesola, on March 24. Dad, Mother and baby are happy and healthy. . . . Dennis and **Karen Brothers,** who are apparently the winners of the first-baby-born-to-a-'68 coed contest, are now vying for second-baby honors with the birth of a daughter, Shannon Jeanne (coed in '93??) on June 16. . . . Another response to our plea to spouses has brought some news about **Bob Bengen** from his wife Joann. First, they report the birth of their first child (a prospective patient for Dave Swedlow) on July 1. After graduation, Bob taught high school science for a year, then joined Raytheon as a systems analyst. He is now back in school, courtesy of a lucky lottery number, and is studying for a M.B.A. at the University of Manchester.

Notes from Nepal

Gary Ender, who is completing his third year in the Peace Corps in Nepal, has written to let us know about his own activities, and to try to inspire some of his friends to do likewise. He is working as an agricultural agent, living in a village in southern Nepal, on the northern-most part of the Gangetic Plain. He reports: "We were trained to work mostly in grain crops—rice, wheat and corn—but I have also worked with jute, pigs, plows, vegetables and fruits. I have seen local farmers become firmly convinced of the advantages of the government's improved seed, implements, etc., and although there has been no revolution in farming in my village, I feel that my upcoming departure will not be untimely. There are now farmers who know as much as I do and can explain methods and advantages to their neighbors." Gary reports that he enjoyed his work in agriculture so much that he wants to study it when he gets back to the States to fill in some gaps in his knowledge in the field. Next year, however, he expects to go to Japan to teach English (with Berlitz), and also to see Japan, learn Japanese, and possibly study Zen. Gary spent nearly all his vacation in the hills of Nepal. This included an enjoyable trek to the *foot* of Mt. Everest (just behind the International Expedition that barely failed).

Miscellany

A smattering of other news, as space allows, of people going in and out of school, the military, and jobs. **Karl Hella** completed his two and one-half years of military service in April, with the final 11 months in Vietnam. He calls the whole tour a learning experience, including a year of Vietnamese language training. After a summer of unemployment, he entered graduate school in economics at Washington University, St. Louis. . . . Entering the military complex is **John Niles,** who was commissioned Ensign, U.S.N.R., on July 1, as an aviation maintenance management designator.

Eric Schuetz reports that on July 1, he completed three years on the Manufacturing Management Program with G.E. His latest assignment with Ordnance Systems had him working on the guidance assembly for the Poseidon missile designed and controlled by the D-Lab. Eric and his wife moved from Lenox in September, when he entered Harvard Business School. . . . **Curtis Blaine** is working for Kraft Foods in Chicago as an Operations Research analyst. He reports that he has also done some speculating in the commodities market. . . . **Buck Haberkorn** is now working as a security analyst, specializing in New England area companies, with Tucker, Anthony, and R. L. Day in Boston. . . . **Armen Varteressian** reports that **Stan Gottschalk** is currently working toward his Ph.D. at the University of Melbourne. He loves every minute of it, except for occasional skirmishes with his draft board. Stan invites anyone who feels like "dropping by" to visit him there! . . . **Richard Parker** recently finished his dissertation research in Economics at Boston College. His work involved a study of the effects of U.S. military spending on the inter-regional distribution of income in the U.S. On September 2, he joined the faculty of the University of Illinois at Urbana-Champaign. Richard reports that his family is looking forward to mid-west living. . . . **Thomas Penn** reports that he received his M.B.A. from the Stanford School of Business in June. . . . Another recent graduate is **Conrad Kowalski,** who received an M.S. in chemistry from Caltech, also in June.

Finally, I am exceptionally pleased to report the completion of my own doctoral research on August 26. This happens to be the anniversary of women's suffrage, but I swear I didn't plan it that way! I did my work—"Radiation Damage Studies in Crystals by Means of Proton Channelling"—in the Nuclear Engineering Department at M.I.T. Now, I will be looking for employment while Mike completes his thesis.—**Gail (Halpern)** and **Mike Marcus,** 60 Wadsworth St., Apt. 16A, Cambridge, Mass. 02142

FEATURES

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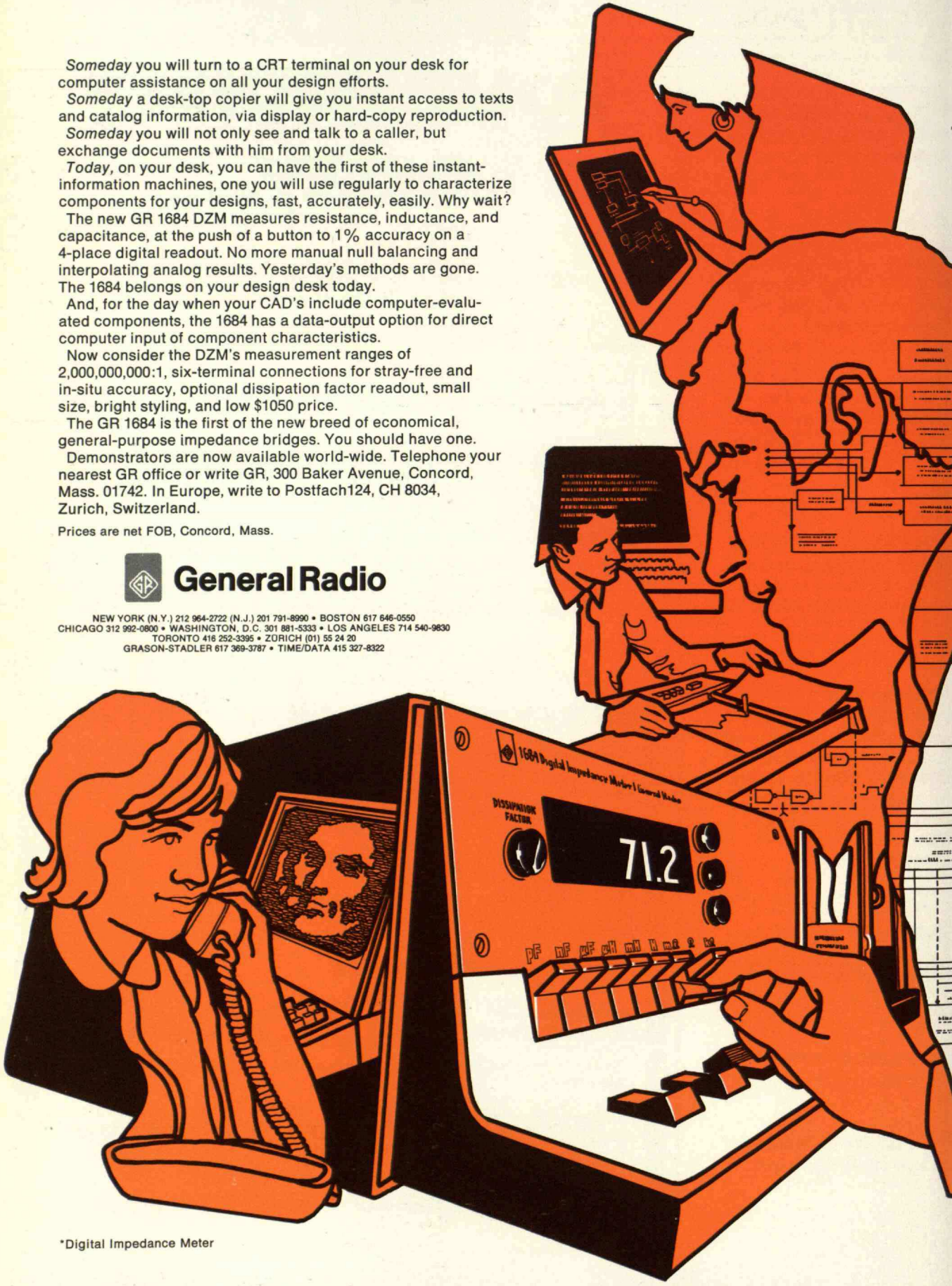

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